

NASA

Energy  
A Continuing  
Bibliography  
with Indexes

NASA SP-7043(35)  
October 1982

National Aeronautics and  
Space Administration



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## ACCESSION NUMBER RANGES

Accession numbers cited in this Supplement fall within the following ranges.

**STAR (N-10000 Series)**

**N82-22141 - N82-28242**

**IAA (A-10000 Series)**

**A82-28539 - A82-38102**

# **ENERGY**

## **A CONTINUING BIBLIOGRAPHY WITH INDEXES**

### **Issue 35**

**A selection of annotated references to unclassified reports and journal articles that were introduced into the NASA scientific and technical information system and announced between July 1 and September 30, 1982 in**

- *Scientific and Technical Aerospace Reports (STAR)*
- *International Aerospace Abstracts (IAA).*



Scientific and Technical Information Branch

1982

**National Aeronautics and Space Administration**

Washington, DC

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# INTRODUCTION

This issue of *Energy: A Continuing Bibliography with Indexes* (NASA SP-7043(35)) lists 881 reports, journal articles, and other documents announced between July 1, 1982 and September 30, 1982 in *Scientific and Technical Aerospace Reports (STAR)* or in *International Aerospace Abstracts (IAA)*. The first issue of this continuing bibliography was published in May 1974.

The coverage includes regional, national and international energy systems; research and development on fuels and other sources of energy; energy conversion, transport, transmission, distribution and storage, with special emphasis on use of hydrogen and of solar energy. Also included are methods of locating or using new energy resources. Of special interest is energy for heating, lighting, for powering aircraft, surface vehicles, or other machinery.

Each entry in the bibliography consists of a standard bibliographic citation accompanied in most cases by an abstract. The entries are arranged in eight major categories, with *IAA Entries* preceding *STAR Entries* in each category. The citation, and abstracts when available, are reproduced exactly as they appeared originally in *IAA* or *STAR* including the original accession numbers from the respective announcement journals. This procedure, which saves time and money accounts for the slight variation in citation appearances.

Six indexes -- subject, personal author, corporate source, contract number, report number, and accession number -- are included.

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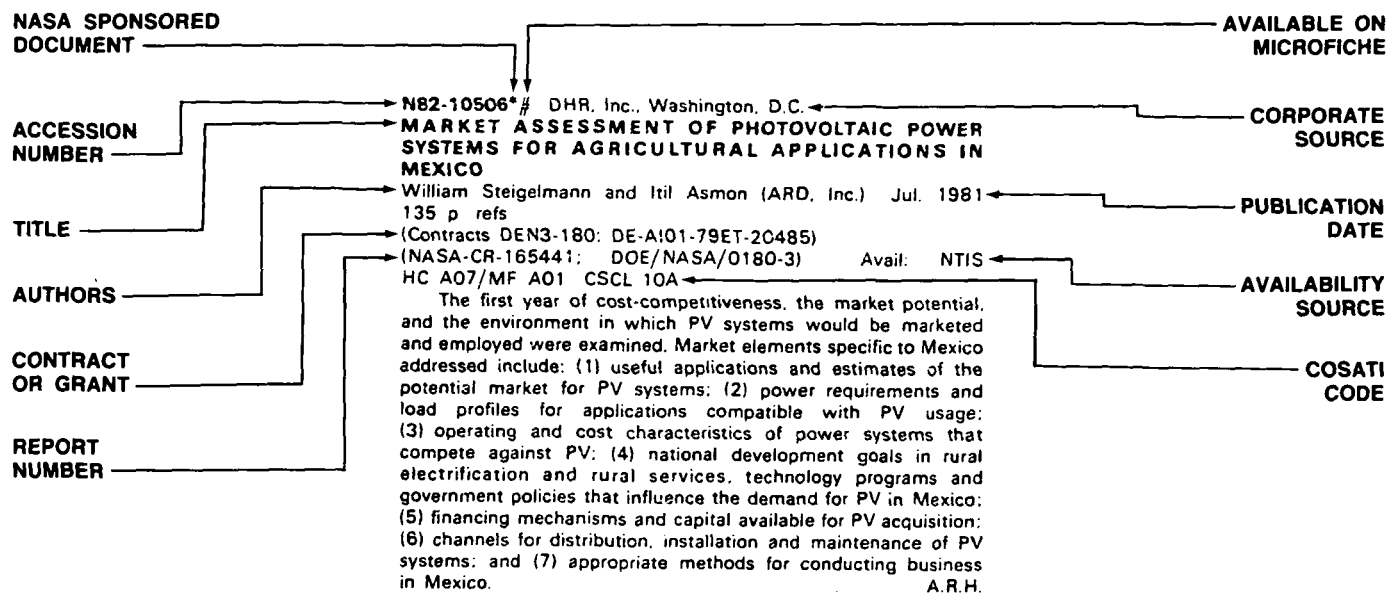
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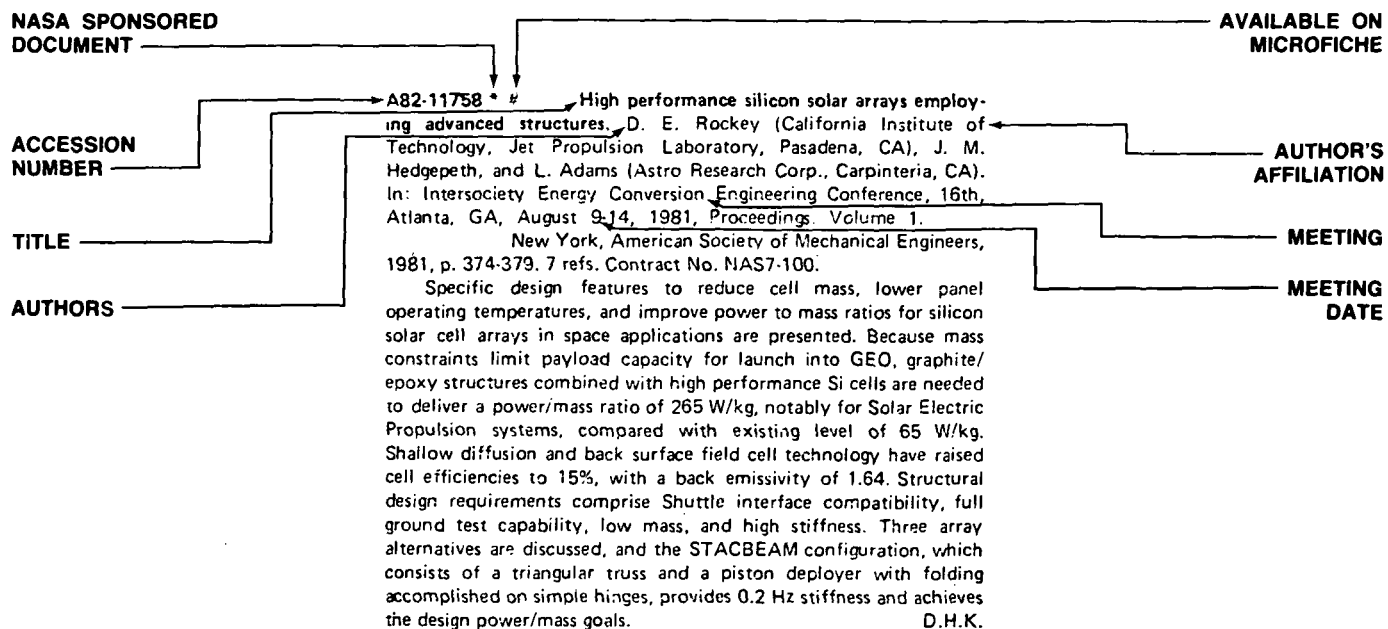
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## TYPICAL CITATION AND ABSTRACT FROM STAR



## TYPICAL CITATION AND ABSTRACT FROM IAA



## **A Listing of Energy Bibliographies Contained in This Publication:**

- |  |               |
|--|---------------|
| 1. Solar Energy Legal Bibliography second update                         | p48 N82-23681 |
| 2. Review of physical and chemical methods for characterization of fuels | p83 N82-26488 |

OCTOBER 1982

01

### ENERGY POLICIES AND ENERGY SYSTEMS ANALYSIS

Includes energy requirements, energy conservation, and environmental impacts of energy systems.

**A82-29425**

**THE SIGNIFICANCE OF COAL AND OTHER SOLID FUELS FOR THE REQUIREMENTS OF THE ENERGY ECONOMY. I - THE PRESENT AND FUTURE SIGNIFICANCE OF SOLID AND OTHER FUELS FOR THE WORLD AND PARTICULARLY WESTERN EUROPE [BEDEUTUNG DER STEINKOHLE UND ANDERER FESTBRENNSTOFFE FÜR DIE VERSORGUNG DER ENERGIEWIRTSCHAFT. I - BISHERIGE UND ZUKUNFTIGE BEDEUTUNG FESTER UND ANDERER BRENNSTOFFE FÜR DIE WELT UND INSBESONDERE WESTEUROPA]**

R.-R. JAKISCH and C. HEMPEL (Ruhrkohle International GmbH, Essen, West Germany) Brennstoff-Wärme-Kraft, vol. 34, Mar. 1982, p. 105-116. In German.

The importance of various energy sources during the last few decades is discussed, and predictions are made for their importance in the eighties and nineties. Coal in the West European market is discussed in relation to other energy carriers with emphasis on the probable areas of demand in the years from 1980 to 2000. Effects of the 1973 oil crisis on the structure of the primary energy consumption up to 1980 are presented. It is predicted that by the year 2000, the world energy consumption of coal will climb to at least 4.4 billion tons of bituminous coal per year. D.L.G.

**A82-29537#**

**SPECTRAL SCANNING OF EXPERIMENTAL PLOTS OF SO<sub>2</sub>-AFFECTED WINTER WHEAT AND SOYBEANS FOR MISSION PLANNING**

C. D. SAPP (Tennessee Valley Authority, Chattanooga, TN) In: Color aerial photography in the plant sciences and related fields; Proceedings of the Eighth Biennial Workshop, Luray, VA, April 21-23, 1981. Falls Church, VA, American Society of Photogrammetry, 1981, p. 101-114. refs

A series of TVA experiments is described wherein plots of soybeans and winter wheat plants were grown to the critical seed-filling stage of development, exposed to controlled doses of SO<sub>2</sub>, observed systematically for foliar effects, then scanned row by row with a spectroradiometer. The spectral curves were statistically analyzed to determine the changes in spectral reflectance that occur after plants are stressed by SO<sub>2</sub> emissions. For soybeans, the affected subplots had higher visible reflectance, lower IR reflectance, and a lower IR/red ratio. Variance analysis showed significant differences in IR and IR/red reflectance between chlorotic soybeans and unaffected ones; and in red reflectance, IR reflectance and IR/red ratio between necrotic and unaffected ones. Since the wheat subplots showed no chlorosis, analysis of reflectance data concentrates on necrosis, which showed a significant difference in red, IR, and IR/red reflectance between classes of differentially injured wheat. C.D.

**A82-29774**

**FUEL EFFICIENT AND MACH 0.8, TOO**

W. E. ARNDT (Lockheed-Georgia Co., Marietta, GA) Lockheed Horizons, Spring 1982, p. 26-34.

Principles of propfan technology and problems which must be solved for the introduction of propfans to production aircraft are discussed. The Hamilton-Standard concept, introduced in 1975, includes thin profile, swept-back multiple blades (8-10) suitable for cruise speeds of Mach 0.8 with 15-20% less fuel consumption than currently available with turbofans. Studies in loading fatigue are necessary to determine if the cyclic loading caused by high-speed swept back wings will adversely affect the integrity of composite-material propfans. Additional areas of concern are effects on the aerodynamic efficiency of aircraft induced by the presence of multibladed propfans, and the necessity of adding noise-reducing materials to maintain satisfactory cabin noise levels is a potential weight penalty factor. NASA trials on a converted Jetstar are described, along with possible techniques to reduce near- and farfield noise levels. M.S.K.

**A82-32147**

**THE BR/CL RATIO IN ATMOSPHERIC AEROSOLS AS A TRACER OF AUTOMOBILE POLLUTION [LE RAPPORT BR/CL DANS L'AEROSOL ATMOSPHERIQUE COMME TRACEUR DE LA POLLUTION AUTOMOBILE]**

C. ELICHEGARAY, R. VIE LE SAGE, B. GRUBIS, and J. L. COLIN (Paris VII, Université, Paris, France) Pollution Atmosphérique, vol. 24, Jan.-Mar. 1982, p. 37-41. In French. refs

The use of antiknock additives in automotive fuels has been found to cause an increase in exhaust emissions of chlorine and bromine as well as lead. The present paper examines the potential of the Br/Cl ratio as an indicator of the contribution of automobiles to atmospheric chlorine levels. Review of the atmospheric chemistry of aerosols of automotive origin reveals the value of the Br/Cl ratio to reflect the relative proportions of the elements in gasoline additives, which range from 0 to 2.25. These values are significantly more than those expected in aerosols from natural or nonautomotive anthropogenic sources. A means for the calculation of the automobile contribution to atmospheric aerosols based on the assumption of the maximum Br/Cl ratio in automotive exhausts is presented and applied to a set of sampling data acquired for Paris, for which it is found that automotive sources account for about 14 percent of the particulate chlorine. A.L.W.

**A82-33250**

**PRINCIPLES OF EFFICIENT ENERGY USE AT INTERFLUG [GRUNDSATZE DER RATIONELLEN ENERGIEANWENDUNG BEI DER INTERFLUG]**

K. HENKES (Ministerium fuer Verkehrswesen; Gesellschaft fuer Internationalen Flugverkehr mbH, Berlin, East Germany) Technisch-oekonomische Information der zivilen Luftfahrt, vol. 17, no. 5-6, 1981, p. 214-220. In German.

Attention is given to the problems of efficient energy use in civil aviation, taking into account conditions in the German Democratic Republic and its Interflug airline. It is pointed out that 98% of the energy requirements of Interflug are met with the aid of energy carriers produced from petroleum. These energy carriers are almost exclusively aircraft fuels, and 50% of the fuel is obtained in refueling operations conducted in foreign countries. Interflug has, therefore, been concerned with the implementation of

## 01 ENERGY POLICIES AND ENERGY SYSTEMS ANALYSIS

approaches for reducing the performance-related fuel consumption for its aircraft. A reduction in performance-related fuel consumption of 10-16% for each aircraft type could be achieved. This reduction is partly the result of organizational steps leading to a more efficient utilization of the aircraft, and partly the result of a number of suitable technical-technological procedures. Plans are discussed for a further reduction of the requirements for fuel and electric power by a variety of different approaches. G.R.

### A82-33407

#### DUST-EMISSION MEASUREMENTS IN TWO POWER PLANTS [STAUB-EMISSIONS-MESSUNGEN IN ZWEI KRAFTWERKEN]

H. SCHNITZLER Staub - Reinhaltung der Luft, vol. 42, Jan. 1982, p. 15-21. In German. Research supported by the Bundesministerium des Innern. refs

Various emission measuring instruments for continuous and quasi-continuous recording of the dust concentration in waste gases were tested in coal-fired and oil-fired power plants. New methods of the acquisition, processing, and evaluation of measured values are described. The average dust concentration in waste gases amounted to 100-135 mg/cu m in the coal-fired plant and about 14 mg/cu m in the oil-fired plant, based on standard conditions. Examples are given of dust emission controls of several days' duration. C.D.

### A82-34113#

#### SOLUTIONS TO THE AVIATION FUEL PROBLEM

W. M. HAWKINS (Lockheed Aircraft Corp., Burbank, CA) In: *International aerospace review; Proceedings of the First International Aerospace Symposium*, Le Bourget, Seine-Saint-Denis, France, June 2, 3, 1981. New York, American Institute of Aeronautics and Astronautics, 1982, p. 165-180.

Projections of the duration of availability of petroleum-derived jet fuels are reviewed and candidates for alternative fuels are discussed. World production of crude oil is expected to begin to irreversibly decline in the 1990s, and the design of new aircraft which could use alternative fuels is noted to depend strongly on the new fuels which have yet to be chosen. Any new fuel supply will be required to have a low producibility cost, be continuously replenishable, be available for multiple uses, be easy to handle and transport, safe to use, cause no major changes in equipment, and be minimally polluting. An additional consideration is that the fuel could be derived where used to avoid the political problems inherent in current fuel supplies. Liquid hydrogen is found to be the best solution because of light weight, water as the source, available everywhere, and costs less than shale or coal-derived fuels. M.S.K.

### A82-34119#

#### SPACE AND ENERGY - A GLOBAL VIEWPOINT

D. E. KOELLE (Messerschmitt-Boelkow-Blohm GmbH, Munich, West Germany) In: *International aerospace review; Proceedings of the First International Aerospace Symposium*, Le Bourget, Seine-Saint-Denis, France, June 2, 3, 1981. New York, American Institute of Aeronautics and Astronautics, 1982, p. 249-260. refs

Possible contributions by organizations involved with space technology to the alleviation of a projected catastrophic world energy crisis which may begin around the year 2000 are discussed. Space disposal of long-lived radionuclides from burnt-out reactor rods is suggested as a viable means to reducing the time required for the remaining fission products which would be geologically imbedded to decay to background levels in 20 yr. An additional cost to consumers of 0.1 cent/kWh is projected using a ballistic missile to remove all the high level wastes from the U.S. and European nuclear power plants. Satellite solar power systems are calculated to depend on a reduction in cost/kWh from 20-50 dollars to 0.50 cents and two orders of magnitude in transportation to attain economic viability. M.S.K.

### A82-34980#

#### ENERGY EFFICIENT ENGINE /E3/ TECHNOLOGY STATUS

W. B. GARDNER (United Technologies Corp., Commercial Products Div., East Hartford, CT) AIAA, SAE, and ASME, Joint Propulsion Conference, 18th, Cleveland, OH, June 21-23, 1982, AIAA 10 p. refs

(AIAA PAPER 82-1052)

The Energy Efficient Engine (EEE) Technology program has the objective to establish the technology readiness of components and subsystems which could be utilized in turbofan engines in the late 1980's, early 1990's. A description is presented of the results of the supporting technology programs, the status and results of the component verification testing to date, and the possibilities for employing the developed technology in connection with the design of an energy efficient, environmentally acceptable engine for the 1990's. Attention is given to aspects of shroudless fan fabrication, the diffuser/compressor model, a compressor sector rig, an uncooled high-pressure turbine rig, supersonic high-pressure turbine cascades, a high-pressure turbine cooling model, aspects of high-pressure turbine leakage control, and subsonic cascades. G.R.

### A82-35235

#### THE VALUE OF SEASONAL CLIMATE FORECASTS IN MANAGING ENERGY RESOURCES

E. B. WEISS (Georgetown University, Washington, DC) *Journal of Applied Meteorology*, vol. 21, Apr. 1982, p. 510-517. NSF-supported research. refs

### A82-35479#

#### TECHNOLOGY ADVANCEMENTS FOR ENERGY EFFICIENT AIRCRAFT ENGINES

R. W. BUCY (General Electric Co., Cincinnati, OH) AIAA, SAE, and ASME, Joint Propulsion Conference, 18th, Cleveland, OH, June 21-23, 1982, AIAA 9 p. refs

(AIAA PAPER 82-1051)

The rapid increase in fuel costs since 1973 has been a major influence on the economics of the commercial aircraft fleet. The development of more fuel efficient aircraft engines has, therefore, become an important priority for aircraft engine manufacturers and NASA. Major goals of a program designed to achieve better fuel efficiency include, relative to the CF6-50C reference engine, 12% reduction in installed Specific Fuel Consumption (SFC), 5% reduction in Direct Operating Costs (DOC), and 50% reduction in the SFC deterioration rate in commercial service. A description is presented of the progress made, in connection with the considered program, over the past four and one-half years. Attention is given to component and engine development tests, the fan component test, high pressure compressor component tests, combustor component tests, high and low pressure turbine component tests, and overall systems integration. G.R.

### A82-35881

#### PROPELLERS COME FULL CIRCLE

R. DEMEIS *High Technology*, vol. 2, July-Aug. 1982, p. 16-18.

The use of the propfan in future aircraft is discussed. With the large external fan generating more thrust per engine revolution than a small internal fan, propfan jets could achieve fuel savings as high as 25 percent in commercial operations and 35 percent for military patrol missions, while retaining the vibration-free operation and mechanical simplicity of turbojet engine cores. The propfan would have as many as 12 stiff composite blades that would be highly swept, thinner, and shorter than conventional blades in order to reduce noise and drag. The gearbox would be reintroduced to permit operation at maximum efficiency with the best blade rotation speed for the airflow conditions. A double-wall insulated fuselage and shaped wing-nacelle interface would deal with internal aircraft noise and propfan-swept wing integration problems. The development of the propfan may depend on continued government funding to NASA's program. C.D.

**A82-36291\*** National Aeronautics and Space Administration. Langley Research Center, Hampton, Va.

**SOURCES OF ATMOSPHERIC AMMONIA**

R. C. HARRISS and J. T. MICHAELS (NASA, Langley Research Center, Hampton, VA) American Meteorological Society, American Geophysical Union, and NASA, Symposium on the Composition of the Nonurban Troposphere, 2nd, Williamsburg, VA, May 25-28, 1982, Paper. 3 p. refs

The information available on factors that influence emissions from the principal societal sources of ammonia to the atmosphere, namely combustion processes, volatilization of farm animal wastes, and volatilization of fertilizers, is reviewed. Emission factors are established for each major source of atmospheric ammonia. The factors are then multiplied by appropriate source characterization descriptors to obtain calculated fluxes of ammonia to the atmosphere on a state-by-state basis for the United States. C.R.

**A82-36752**

**A REVIEW OF UNITED KINGDOM WINDPOWER**

M. N. MILLAR (Napier College of Commerce and Technology, Edinburgh, Scotland) International Journal of Ambient Energy, vol. 3, Jan. 1982, p. 35-46.

A historical review and an assessment of current U.K. wind energy installations and plans are presented. A 100 kW wind turbine was erected in 1951 in Scotland and operated into the late 1950's. Another machine, the Enfield-Andreau 100 kW machine was built and tested at St. Albans in 1955. It featured hollow blades with airholes which created a pneumatic force for driving a generator located in the tower base. Finally, a 100 kW unit was established on the Isle of Man in 1960. A 22 kW Danish turbine has recently been installed on South Ronaldson Island and serves to create experience with grid interconnected WECS. The British government is constructing a 250 kW prototype and model for a 3 MW, dual-blade, upwind WECS with a 151 ft hub height. Research is continuing on a 130 kW Musgrove VAWT with variable geometry. A total of 21 experimental machines existed in the U.K. in 1981.

M.S.K.

**A82-37065#**

**A SIGNIFICANT ROLE FOR COMPOSITES IN ENERGY-EFFICIENT AIRCRAFT**

G. A. ALTHER (Composite Aircraft Corp., Midland, TX) In: Reinforced Plastics/Composites Institute, Annual Conference, 36th, Washington, DC, February 16-20, 1981, Preprints. New York, Society of the Plastics Industry, Inc., 1981 (Session 12-D). 4 p. refs

The structural advantages and a 10-year in-service history of the Windecker Eagle all fiberglass/epoxy airframes are discussed. In these airframes, the skins are composed of one or more plies of nonwoven unidirectional fiber cloth, the wing spars and other laminates are also composed of multiple oriented plies of fiber cloth, and a ply of nonwoven 0/90 cloth is used for the outermost plies of the laminates and skins to enhance the finish. Stiffening for the skin laminates is provided by composite laminate stringers varying in thickness from 1/4 to 1 inch spaced with polyurethane foam. The fuselage is molded in one-piece halves complete with vertical tail, wing root, and stabilizer junctures, and bonded together at mating flanges along the top and bottom body lines. It is shown that apart from aerodynamics and energy efficiency, the all fiberglass/epoxy airframe provides greater strength, toughness, and redundancy compared to aluminum for equivalent structural weight. V.L.

**N82-22276#** Rolls-Royce Ltd., Derby (England).

**FUEL EFFICIENCY ENGINES FOR LARGE TRANSPORT AIRCRAFT**

D. J. PARFITT 27 Mar. 1981 27 p Presented at Aeron. Soc. of India Conf., Bombay, 27 Mar. 1981 (PNR-90082; MISC-555) Avail: NTIS HC A03/MF A01

The next generation of Rolls Royce aircraft engines is discussed, especially their fuel consumption. For the RB211, improvements on the order of 15% in fuel consumption relative to the initial service standard are planned. Large fan engines are expected to

remain technology leaders in the long-term. Fuel savings on the order of 10% to 15% are feasible, using low specific thrust designs. Noise and exhaust emission improvements are predicted. Advanced wing designs and the use of lightweight composite materials, linked with full authority digital control systems, enhance engine performance. Liquid hydrogen is suggested as a replacement for kerosene, because of its high heating value. Author (ESA)

**N82-22393#** International Business Services, Inc., Washington, D.C.

**INVESTIGATING THE RELATIONSHIP BETWEEN LAND USE PLANNING, TRANSPORTATION AND ENERGY CONSUMPTION Final Report**

B. BURGWALD, W. COLE, and C. WAGNER Jan. 1981 143 p refs

(Contract DTOS59-80-C-0060)

(PB82-122185; DOT/P-10-81/90) Avail: NTIS HC A07/MF A01 CSCI 13B

The relationship among land use, transportation accessibility and energy consumption in and urban context was investigated. The issues addressed include: (1) how transportation accessibility and land use planning interact for increased energy conservation; (2) the role the public sector plays with regard to incorporating and integrating transportation, land use and energy conservation; and (3) the institutional and/or technical barriers for better integration of energy, transportation and land use considerations.

GRA

**N82-22464#** Gordian Associates, Inc., Washington, D. C.

**HEAT PUMP DEMAND CHARACTERISTICS: A STUDY OF THE IMPACTS OF SINGLE-FAMILY RESIDENTIAL HEAT-PUMP TECHNOLOGIES ON ELECTRIC-UTILITY-SYSTEM LOADS Final Report**

A. LANNUS, M. HESSE, and B. APPELBAUM Oct. 1981 145 p refs Sponsored by EPRI

(Contract EPRI PROJ. 1100-1)

(DE82-900861; EPRI-EA-2074) Avail: NTIS HC A07/MF A01

The hourly power demand and heating- and cooling-mode energy use of electric air source heat pumps in single-family residences was analyzed and correlated. Field data from 50 houses in five different geographical locations, representing a range of 1434 to 8310 heating degree days and 2889 to 527 cooling degree days, were selected from a previous field study. A subset of the data was used to test a residential building-heat pump simulation model. Calculated daily heating energy consumption agreed to within 10 to 27% of the measured values; daily cooling energy consumption agreed to within 12 to 23% of the measured values. A Monte Carlo simulation procedure was developed for the prediction of heat pump diversified demand based on a probability sample of residential customers selected on the basis of certain customer-class, equipment, and weather-related characteristics. Due to lack of valid field data, only a crude test of this procedure was possible, but it indicated that this method holds promise in simulations where test metering data are unavailable. DOE

**N82-22537#** Comptroller General of the United States, Washington, D.C.

**STRATEGIC PETROLEUM RESERVE: SUBSTANTIAL PROGRESS MADE, BUT CAPACITY AND OIL QUALITY CONCERNS REMAIN Report to the Congress**

31 Dec. 1981 63 p refs

(EMD-82-19; B-203117) Avail: SOD

During fiscal year 1981, the Government filled the Strategic Petroleum Reserve at an average rate of 292,000 barrels per day, the highest rate achieved for any fiscal year since oil fill began. Efforts since July 1980 to fill the reserve are discussed and it is noted that the Department of Energy will be able to maintain only an average rate of 189,000 barrels per day from fiscal year 1982 to 1989 under current expansion plans. Recommendations concerning the availability of storage capacity and the quality of oil stored in the reserve are given. T.M.

## 01 ENERGY POLICIES AND ENERGY SYSTEMS ANALYSIS

**N82-22585\*#** Aerial Information Systems, Crestline, Calif.  
**APPROPRIATENESS IN USING LANDSAT IN DEVELOPMENT ENERGY RELATED DATA BASES**

E. HARNDEN *In* NASA. Ames Research Center Western Reg. Remote Sensing Conf. Proc., 1981 p 205-209 Sep. 1981 ERTS

Avail: NTIS HC A12/MF A01 CSCL 05B

The use of automated classification systems in the field of resource management and resource inventory is discussed. Applications of LANDSAT classification are outlined and include: energy load forecasting based upon land use inventories and change analysis, impact analysis of activities related to energy extraction, capability/suitability mapping in support of generation and substation location and transmission line routing, and assessment of solar energy potential in a highly urbanized setting where land values are high. It is found that the use of LANDSAT data is adequate for general inventories where few data categories are required, where resolution of data to around 150 acres minimum is required, and where no other complete imagery set can be obtained. T.M.

**N82-22637#** Bergbau-Forschung G.m.b.H., Essen (West Germany).

**TIMESAVING METHODS ADAPTABLE TO MINING WHICH UTILIZE STRUCTURAL INFORMATION ON THE FOREFIELD WHILE APPLYING NEW TECHNOLOGIES Final Report, Jun. 1980**

H. MURAWSKI and K. H. RUELLER Bonn Bundesministerium fuer Forschung und Technologie Dec. 1981 125 p refs *In* GERMAN; ENGLISH summary Sponsored by Bundesministerium fuer Forschung und Technologie (BMFT-FB-T-81-220; ISSN-0340-7608) Avail: NTIS HC A06/MF A01; Fachinformationszentrum, Karlsruhe, West Germany DM 26,45

Fabric data for diagnosis of tectonics in a coal mine was studied. The possibility of combining geophysics, well logging, and structural surveys in forefield research was investigated in the Ruhr district. Subterranean outcroppings in mines were studied. Planes of cleavage, systems of cleats, and genesis of cleats were measured photometrically. A data reduction and display program, PLANICOMP, was improved, and electronic data processing was used to find Braun's index. A tectonic deformation index and basic structure are determined. The system provides sufficient information on the tectonic situation in the forefield and is a practicable aid to the miner. Author (ESA)

**N82-22639#** New England River Basins Commission, Boston, Mass.

**PENOBSCOT RIVER BASIN OVERVIEW**

Sep. 1981 152 p refs Sponsored in part by Water Resources Council

(PB82-131467) Avail: NTIS HC A08/MF A01 CSCL 13B

Water resources issues identified in the Penobscot River basin are discussed and concern hydropower development, minerals development, forestry, and acid rain. Other water resource problems in the basin, principally related to the urban centers in the southern portion, include point source wastewater discharges, water supply needs, some flooding, and access to water-related recreation. GRA

**N82-22640#** New England River Basins Commission, Boston, Mass.

**ST. CROIX/MAINE EASTERN COASTAL RIVER BASINS OVERVIEW: PUBLIC REVIEW DRAFT**

Sep. 1981 161 p refs Sponsored in part by Water Resources Council

(PB82-133091) Avail: NTIS HC A08/MF A01 CSCL 13B

Issues identified in the St. Croix/Maine Eastern Coastal River basins center on proposals for major energy facilities in Cobscook Bay, forestry, acid rain, potential flooding and sometime conflicting uses of the rivers. International concerns are addressed. GRA

**N82-22647#** Comptroller General of the United States, Washington, D.C.

**GREATER ENERGY EFFICIENCY CAN BE ACHIEVED THROUGH LAND USE MANAGEMENT Report to the Congress**

21 Dec. 1981 58 p refs

(EMD-82-1; B-198982) Avail: SOD

An analysis of energy conservation methods based on land use management is given and recommendations are made. When planning new growth and redevelopment, communities can significantly reduce energy consumption by incorporating energy efficient land use concepts such as site and building design, locational planning, and higher density development. Decisionmakers, however, are reluctant to use these concepts because of major barriers such as the cost of implementing the concepts and resistance to higher density development. The Federal Government can play a role in promoting energy-efficient land use by providing guidance through its policies, supporting research and comprehensive planning, and providing needed financial incentives. R.J.F.

**N82-22648** International Institute for Applied Systems Analysis, Laxenburg (Austria).

**THE POSSIBLE SHARE OF SOFT/DECENTRALIZED RENEWABLES IN MEETING THE FUTURE ENERGY DEMANDS OF DEVELOPING REGIONS**

A. M. KHAN Sep. 1981 41 p refs

(RR-81-18; ISBN-3-7045-0015-1) Avail: Issuing Activity

The contribution of soft/decentralized renewables to energy supply in market economy developing regions is discussed. Investment requirements and fuel production costs are compared with conventional supply schemes. Difficulties associated with these technologies are analyzed. The most promising soft/decentralized renewables are: windmills and small hydropower units for use in irrigation and for supplying electricity to rural households and small towns; charcoal for meeting thermal energy requirements of industry, households, and the service sector; biogas for use in rural households; and solar heat for supplying hot water/steam to industry, households, and services. Author (ESA)

**N82-22667#** Midwest Research Inst., Golden, Colo. Solar Energy Research Inst.

**UTILITY SITING OF WECS: A PRELIMINARY LEGAL/REGULATORY ASSESSMENT**

R. J. NOUN, M. LOTKER (Synectics Group, Inc.), and H. P. FRIESEMAN (Inst. of Ecology) May 1981 103 p refs (Contract EG-77-C-01-4042)

(SERI/TR-744-778) Avail: NTIS HC A06/MF A01

The early experiences of several utilities in dealing with the legal and regulatory issues that were raised in the process of siting wind energy installations were examined. Recommendations are made as to how utilities can begin to address many of the identified issues. Two issues associated with utility siting of wind machines are cited: (1) land acquisition and use and (2) aesthetic controls. Land use control regulations dealing with incompatible uses, nuisance factors, building scale limitations, and on site environmental impacts many constrain wind machine siting by utilities. The siting issue of greatest concern is how the public will react to the hard reality of wind power development. Little public opposition to wind energy projects is raised to date, yet it is possible that local attitudes will change as the novelty of the early single unit machines wears off. It is concluded that potentially adverse impacts based on local aesthetic concerns can be minimized by careful planning, siting, and design by utility developers and by close coordination with local planning and regulatory officials. E.A.K.

**N82-22678\*#** Argonne National Lab., Ill.  
**ENVIRONMENTAL ASSESSMENT OVERVIEW**

A. R. VALENTINO *In* NASA, Washington The Final Proc. of the Solar Power Satellite Program Rev. p 37-53 Jul. 1980 refs Avail: NTIS HC A99/MF A01 CSCL 10A

The assessment program has as its objectives: to identify the environmental issues associated with the SPS Reference System;

to prepare a preliminary assessment based on existing data; to suggest mitigating strategies and provide environmental data and guidance to other components of the program as required; and to plan long-range research to reduce the uncertainty in the preliminary assessment. The key environmental issues associated with the satellite power system are discussed and include human health and safety, ecosystems, climate, and interaction with electromagnetic systems. T.M.

**N82-22679\*#** PRC Systems Sciences Co., Los Angeles, Calif.

#### **SOCIETAL ASSESSMENT OVERVIEW**

C. E. BLOOMQUIST /in NASA, Washington The Final Proc. of the Solar Power Satellite Program Rev. p 54-77 Jul. 1980 refs

Avail: NTIS HC A99/MF A01 CSCL 10A

The decision to proceed with SPS depends on a political determination that commitment of the economic, institutional, and social energies required for its implementation is a worthwhile investment. This determination is national (and international) in scope and is based on knowledge of the environmental and societal impacts of the SPS, its projected economics and technological risks, expressed through the influence of contending segments of society. To assist the decision makers, an assessment of societal issues associated with the SPS was undertaken as part of the Concept Development and Evaluation Program. Results of the assessment are reported. The primary societal assessment objectives are to determine if the societal ramifications of an SPS might significantly impede its development, and to establish an information base regarding these issues. Estimates regarding SPS impacts commensurate with its stage of development and the needs of the decision makers are provided. T.M.

**N82-22680\*#** European Space Research and Technology Center, Noordwijk (Netherlands).

#### **AN OVERVIEW ON EUROPEAN SPS ACTIVITIES**

K. K. REINHARTZ /in NASA, Washington The Final Proc. of the Solar Power Satellite Program Rev. p 78-87 Jul. 1980 refs

Avail: NTIS HC A99/MF A01 CSCL 10A

The organization of space and energy research in Europe is discussed. The European situation is highlighted with emphasis on the dependency of energy imports and on the energy requirements of Europe. The status of SPS research in the countries that form the European Space Agency was reviewed. It is concluded that in view of the unfavorable geographical and climatic situation of large parts of Europe, terrestrial solar energy conversion is unlikely to make a significant contribution to Europe's future energy supply. Thus, SPS development is of special interest to the European community. T.M.

**N82-22688\*#** Argonne National Lab., Ill.

#### **OVERVIEW OF ATMOSPHERIC EFFECTS**

D. M. ROTE /in NASA, Washington The Final Proc. of the Solar Power Satellite Program Rev. p 113-115 Jul. 1980

Avail: NTIS HC A99/MF A01 CSCL 10A

Effluents from the transportation system are the major cause of Satellite Power System related atmospheric effects. These effects are discussed and include inadvertent weather modification, air quality degradation, compositional changes in the stratosphere and mesosphere, formation of noctilucent clouds, plasma density changes, airglow enhancements, and changes in composition and dynamics of the plasmasphere and magnetosphere. L.F.M.

**N82-22689\*#** Institute for Telecommunication Sciences, Boulder, Colo.

#### **IONOSPHERIC DISTURBANCE OVERVIEW**

C. M. RUSH /in NASA, Washington The Final Proc. of the Solar Power Satellite Program Rev. p 116-119 Jul. 1980

Avail: NTIS HC A99/MF A01 CSCL 10A

A program of research and exploratory development was undertaken to assess the potential impact of Satellite Power System operation on the ionosphere. The program relies on the utilization of ground-based ionospheric heating facilities in order to simulate the ionospheric heating that will come from the Satellite Power

System. Thus far, the experimental program directed toward assessing telecommunications impacts has received the most attention, and little impact was observed on VLF, LF, and MF operations. L.F.M.

**N82-22690\*#** Pacific Northwest Lab., Richland, Wash.

#### **ELECTROMAGNETIC COMPATIBILITY OVERVIEW**

K. C. DAVIS /in NASA, Washington The Final Proc. of the Solar Power Satellite Program Rev. p 120-121 Jul. 1980

Avail: NTIS HC A99/MF A01 CSCL 10A

An assessment of the electromagnetic compatibility impact of the Satellite Power System is discussed. The discussion is divided into two parts: determination of the emission expected from SPS including their spatial and spectral distributions, and evaluation of the impact of such emissions on electromagnetic systems including considerations of means for mitigating effects. L.F.M.

**N82-22691\*#** California Univ., Berkeley. Lawrence Berkeley Lab.

#### **NONMICROWAVE HEALTH AND ECOLOGICAL EFFECTS: OVERVIEW**

M. R. WHITE /in NASA, Washington The Final Proc. of the Solar Power Satellite Program Rev. p 122-123 Jul. 1980

Avail: NTIS HC A99/MF A01 CSCL 10A

The potential environmental impacts due to the operation and construction of the Satellite Power System are discussed. The nonmicrowave health and ecological effects encompass impacts on the public, the terrestrial worker, the space worker, the ecology, and agriculture. L.F.M.

**N82-22692\*#** Environmental Protection Agency, Research Triangle Park, N.C. Experimental Biology Div.

#### **SPS MICROWAVE HEALTH AND ECOLOGICAL EFFECTS: PROGRAM AREA OVERVIEW**

D. F. CAHILL /in NASA, Washington The Final Proc. of the Solar Power Satellite Program Rev. p 124 Jul. 1980

Avail: NTIS HC A99/MF A01 CSCL 10A

The potential microwave health and ecological effects due to the operations of the Satellite Power System are discussed. An outline of the research needed to insure public acceptance of the program is presented. L.F.M.

**N82-22693\*#** PRC Energy Analysis Co., Los Angeles, Calif.

#### **AN EVALUATION OF THE LAND AND MATERIAL REQUIREMENTS FOR THE SATELLITE POWER SYSTEM**

S. D. ANKERBRANDT /in NASA, Washington The Final Proc. of the Solar Power Satellite Program Rev. p 125-128 Jul. 1980

Avail: NTIS HC A99/MF A01 CSCL 10A

Current research and evaluation of the physical resources requirements for the Satellite Power System (SPS) concentrates on three topics: land requirements and the siting of rectennas; the environmental impacts of the rectenna siting; and the materials requirements. The first two focus exclusively on the Earth based element of the SPS while the materials assessment considered requirements for both the space and Earth systems. L.F.M.

**N82-22696\*#** Argonne National Lab., Ill.

#### **COMPARATIVE HEALTH AND SAFETY ASSESSMENT OF THE SPS AND ALTERNATIVE ELECTRICAL GENERATION SYSTEMS**

L. J. HABEGGER, J. R. GASPER, and C. D. BROWN /in NASA, Washington The Final Proc. of the Solar Power Satellite Program Rev. p 150-153 Jul. 1980

Avail: NTIS HC A99/MF A01 CSCL 10A

A comparative analysis of health and safety risks is presented for the Satellite Power System and five alternative baseload electrical generation systems: a low-Btu coal gasification system with an open-cycle gas turbine combined with a steam topping cycle; a light water fission reactor system without fuel reprocessing; a liquid metal fast breeder fission reactor system; a central station terrestrial photovoltaic system; and a first generation fusion system with magnetic confinement. For comparison, risk from a decentralized roof-top photovoltaic system with battery storage is

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also evaluated. Quantified estimates of public and occupational risks within ranges of uncertainty were developed for each phase of the energy system. The potential significance of related major health and safety issues that remain unquantified are also discussed.

M.D.K.

**N82-22716\*#** Power Conversion Technology, Inc., San Diego, Calif.

### **COMPARISON OF LOW EARTH ORBIT AND GEOSYNCHRONOUS EARTH ORBITS**

J. E. DRUMMOND /in NASA, Washington The Final Proc. of the Solar Power Satellite Program Rev. p 234-236 Jul. 1980 refs

Avail: NTIS HC A99/MF A01 CSCL 10A

The technological, environmental, social, and political ramifications of low Earth orbits as compared to geosynchronous Earth orbits for the solar power satellite (SPS) are assessed. The capital cost of the transmitting facilities is dependent on the areas of the antenna and rectenna relative to the requirement of high efficiency power transmission. The salient features of a low orbit Earth orbits are discussed in terms of cost reduction efforts.

E.A.K.

**N82-22754\*#** Argonne National Lab., Ill. Energy and Environmental Systems Div.

### **RECTENNA RELATED ATMOSPHERIC EFFECTS**

J. LEE /in NASA, Washington The Final Proc. of the Solar Power Satellite Program Rev. p 440-443 Jul. 1980 refs

Avail: NTIS HC A99/MF A01 CSCL 10A

Possible meteorological effects arising from the existence and operations of a solar power satellite (SPS) system rectenna are examined. Analysis and model simulations in some chosen site situations and meteorological conditions indicate that the meteorological effects of the construction and operation of a rectenna are small, particularly outside the boundary of the structure. From weather and climate points of view, installation of an SPS rectenna seems likely to have effects comparable with those due to other nonindustrial land use changes covering the same area. The absorption and scattering of microwave radiation in the troposphere would have negligible atmospheric effects.

M.G.

**N82-22769#** Department of Energy, Washington, D. C. Office of Environmental Assessments.

### **COAL-FIRED POWER PLANT (WESTERN COAL): ENVIRONMENTAL CHARACTERIZATION INFORMATION REPORT**

Jan. 1981 67 p refs Prepared in cooperation with Aerospace Corp., Germantown, Md.

(Contract DE-A703-76EV-74010)

(DOE/EP-0019) Avail: NTIS HC A04/MF A01

The latest available environmental and technical information on coal-fired power plants was collected from a number of sources. The typical plant chosen for characterization was a 500/MWE pulverized-coal plant burning western low-sulfur coal. The plant uses an electrostatic precipitator, a lime/limestone scrubber, and a wet, mechanical draft cooling tower. The plant fuel is supplied from offsite mines by unit-train deliveries with surface mined, thick seam coal, which undergoes minimum preparation prior to pulverization. The process, plant operating parameters, resources needed, and environmental residuals and products associated with the power plant are presented. Annual resource usage and pollutant discharges are given, assuming an annual plant capacity factor of 80 percent. Quantities are given in terms of ten to the twelfth power Btu's of electric energy produced. Several plants are discussed individually. Environmental regulations are discussed. The overall physical requirements of the plant for land and water are discussed.

R.J.F.

**N82-22771#** National Building Research Inst., Pretoria (South Africa).

### **ENERGY CONSERVATION IN HOUSES. A TECHNICAL PRESS DAY REPORT ON THE RESULTS OF THE LOW ENERGY EXPERIMENTAL HOUSE PROJECT IN GARSFONTEIN, PRETORIA**

7 Jul. 1981 14 p refs

Avail: NTIS HC A02/MF A01

The low energy experimental house project demonstrated that a home constructed from traditional materials, by traditional methods, maintains an acceptable indoor thermal environment with low levels of energy utilization, and evaluated the long term cost benefits of different energy saving options. Both the experimental and the demonstration aspects necessitated the use of full scale houses. Two such houses were built in Pretoria, one of which was to serve as a control. They were both typical well designed middle income homes, but the low energy house embodied a number of energy saving design features as well as an air based space and water heating solar system. The floor plans of both houses were similar and that of the low energy house is presented.

S.L.

**N82-22772#** Joint Economic Committee (U. S. Congress).

### **A NATIONAL INDEX FOR ENERGY PRODUCTIVITY**

A. PENZ and D. BAKKE Washington GPO 1981 46 p refs Rept. presented to the Joint Econ. Comm., 97th Congr., 1st Sess., 13 May 1981 Prepared by Mellon Inst., Arlington, Va.

(GPO-75-886) Avail: SOD HC

Possible indices to measure changes in energy productivity are explored. These indices could provide the nation with better information about how it uses energy. It is recommended that certain uses of these indices be adopted and widely disseminated by government. The widespread use of an energy productivity index by the government and in the media could provide many significant benefits: (1) it signals the importance that government attaches to increasing energy efficiency; (2) it focuses and sustains national attention on this critical energy strategy; (3) an energy productivity index motivates and challenges the nation; (4) it serves as an early warning system that current approaches are not working and new approaches are called for; (5) it is a useful tool for public planners and policy makers in predicting future energy productivity trends; and (6) energy productivity indices increase the public's understanding of energy services. It is concluded that the adoption of a systematic dissemination of the indices will enhance public understanding of energy productivity and contribute to maximizing energy efficiency.

E.A.K.

**N82-22781#** Rocket Research Corp., Redmond, Wash.

### **UTILIZATION OF WASTE HEAT FROM MAJOR TRANSFORMER SUBSTATIONS. VOLUME 3: APPENDIX Final Report**

N. T. CHRISTENSEN, K. W. ARASIM, C. R. ROBERTS, G. V. GIBNEY, and W. PRICE Aug. 1981 152 p refs Sponsored by EPRI Prepared in cooperation with Seattle City Light and Henningson, Durham and Richardson, P.S.

(Contract EPRI PROJ. 1274-1)

(DE82-900357; EPRI-EM-1968-VOL-3) Avail: NTIS HC A08/MF A01

Large substation transformers reject substantial thermal energy. Since these units are usually close-coupled to facilities requiring low-temperature thermal energy for space conditioning, the ability to recover and efficiently utilize this energy is of significant interest. A general system was designed and optimized for the recovery of transformer waste heat. Simplified analytical techniques were developed to assist utilities in both preliminary analysis and detail design analysis of specific systems, including system economics. Critical component performance parameters were identified for the preparation of detailed specifications. Criteria for the specific application of such systems through system economics are presented.

T.M.

**N82-22790#** General Energy Associates, Cherry Hill, N.J.  
**NEW YORK STATE INDUSTRIAL ENERGY PROFILE, VOLUME 1 Final Report**

B. B. HAMEL and B. L. BROWN Apr. 1981 250 p  
 (PB82-126848; REPT-49/EU-IUU/79-1-VOL-1;  
 NYSERDA-81-9-1-VOL-1) Avail: NTIS HC A11/MF A01 CSCL 10A

A New York State industrial energy data base compatible with the national data base which includes industrial energy use on a national level and energy recovery technologies was studied. The data base is a comprehensive New York industrial energy use profile by county and 4 digit standard industrial classification (SIC) and includes the following process and waste energy fuel type, plant size, and employee distribution. Total energy consumption in the manufacturing sector in New York State. GRA

**N82-22791#** California Energy Commission, Sacramento.  
**ELECTRICITY TOMMORROW Final Report**

Jan. 1981 490 p  
 (PB82-124165; CAEC-81) Avail: NTIS HC A21/MF A01 CSCL 10A

The critical issues for the electricity sector in California were presented. Adopted level of electricity demand and adopted policies and supply criteria are included. These form the basis for planning and certification of electric generation and transmission facilities by the energy commission. Estimates of the potential contributions of conservation and various conventional and alternative supply sources, critiques of utility supply plans, and determinations of how much new capacity is required are also included. Policy recommendations for directing public and private investments into preferred energy options, for spreading the benefits and costs of these options broadly and fairly among California's citizens, and for removing remaining obstacles to the development of all acceptable energy sources are presented. GRA

**N82-22792#** Minnesota Energy Agency, St. Paul.  
**THE POTENTIAL FOR UTILITY CONSERVATION INVESTMENTS IN MINNESOTA**

Jan. 1981 285 p  
 (PB82-122219; MEA-1-81) Avail: NTIS HC A13/MF A01 CSCL 10A

The need for utility investments in conservation is analyzed. A framework for carrying out such an analysis, and goals for a conservation program are developed. Issues which stand in the way of achieving those goals are examined. The desirability of alternative utility conservation strategies is assessed. Policy recommendations are made for the Minnesota public utilities commission to consider in establishing a utility conservation investment pilot program. GRA

**N82-22793#** National Materials Advisory Board, Washington, D. C. Commission on Sociotechnical Systems.

**AN ASSESSMENT OF THE INDUSTRIAL ENERGY CONSERVATION PROGRAM. VOLUME 1: SUMMARY Final Report, Nov. 1980 - Jul. 1981**

Sep. 1981 50 p refs  
 (Contract DE-AC01-80CS-40298)  
 (PB82-122755; NMAB-395-1) Avail: NTIS HC A03/MF A01 CSCL 10A

Findings and recommendations of the industrial energy conservation program are summarized. Industrial operations in the U.S. consume some 37% of the country's total energy. This percentage will increase to 50% by 1980 unless appropriate conservation measures are applied. Conservation measures are difficult to implement. It is concluded that improvements for conservation are needed in the areas of: project selection, project management, and transfer of results to industry. GRA

**N82-22803#** Department of Energy, Mines and Resources, Ottawa (Ontario). Center for Mineral and Energy Technology.

**EFFECT OF HEATED DIESEL FUEL ON PARTICULATE GENERATION AND FUEL CONSUMPTION FOR A DEUTZ F6L 912 ENGINE**

E. D. DAINTY and J. P. MOGAN Jun. 1980 10 p  
 (DE82-900385; ERP/ERL-80-65(TR)) Avail: NTIS (US Sales Only) HC A02/MF A01; DOE Depository Libraries

The effects of fuel temperature on fuel consumption and on the concentrations of CO and carbon particulate matter in the exhaust gases generated at near maximum load/speed operating conditions was determined. It is found that for a given engine torque and speed, and fuel temperature increases from 750 F/240 C to 180DF/830 C: there is no significant variation in fuel flow rate; there is no significant overall variation in the generation of particulate matter; and a minor 12% reduction in the generation of CO takes place. It does not appear that this emissions reduction strategy is useful in underground applications where IDI engines are widely used. DOE

**N82-22810#** STEAG A.G., Essen (West Germany). Hauptbereich Kraftwirtschaft.

**MELTING CHAMBER COMBUSTION WITH REDUCED EMISSION OF NITROGEN OXIDES Final Report**

H. STEBEL and U. STRAUSS Bonn Bundesministerium fuer Forschung und Technologie Dec. 1981 32 p refs In GERMAN; ENGLISH summary Sponsored bu Bundesministerium fuer Forschung und Technologie (BMFT-FB-T-81-228; ISSN-0340-7608) Avail: NTIS HC A03/MF A01; Fachinformationszentrum, Karlsruhe, West Germany DM 7,55

A pilot plant intended to test a stoking concept, incorporating melting chambers with reduced emission of NOx, is described. Comparable liquefied coal combustion schemes show values of NOx emission of 950 to 1150 vpm. Values for the pilot plant of 650 vpm are realized, combining stable stoking of the melting chamber and flame optimization. It is found that it is possible to recirculate up to 14% of total flue gas through the combustion chamber. Under these conditions NOx emissions are reduced to 540 vpm, however, variable accommodation of the recirculated flue gas volume to the boiler load regime is necessary.

Author (ESA)

**N82-22811#** Southwest Research Inst., San Antonio, Tex. Dept. of Emissions Research.

**CHARACTERIZATION OF EXHAUST EMISSIONS FROM HIGH MILEAGE CATALYST-EQUIPPED AUTOMOBILES**

L. R. SMITH Sep. 1981 191 p refs  
 (Contract EPA-68-03-2884)  
 (PB82-131566; EPA-460/3-81-024) Avail: NTIS HC A09/MF A01 CSCL 13B

Ten automobiles were evaluated (as-received and after a tune-up to manufacturer's specifications) over the Light-Duty Federal Test Procedure (FTP) and the Highway Fuel Economy Driving Schedule (HFET). Exhaust constituents measured, in addition to the regulated emissions, include: aldehydes, particulates, sulfides, amines, metals, and several additional elements and compounds. Additional evaluations involved the measurement of the regulated emissions over four short-test procedures. GRA

**N82-23043#** Comptroller General of the United States, Washington, D.C.

**STREAMLINING AND ENSURING MINERAL DEVELOPMENT MUST BEGIN AT LOCAL LAND MANAGEMENT LEVELS Report to the Chairman, Committee on Energy and Commerce, House of Representatives**

4 Dec. 1981 24 p refs  
 (EMD-82-10; B-205344) Avail: SOD

A study of the use of Federal lands, particularly military lands, concluded that success in streamlining and accelerating mineral development on Federal lands depends on the Bureau of Land Management state offices ultimately responsible for the implementation of Department of Interior minerals policies. It was

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found the eastern States Office of the Bureau of Land Management did not effectively deal with potential Federal mineral trespass in the East, and was unable to issue mineral leases and permits on a timely basis. Moreover, it was unable to effectively deal with new areas of mineral interest because of Department actions. Recommendations to improve the mineral trespass program help relieve lease and permit backlogs, maintain dedicated staff, and improve headquarters communications with State offices were made. R.J.F.

**N82-23068#** Committee on Science and Technology (U. S. House).

### **THE 1983 NASA AUTHORIZATION, VOLUME 1**

Washington GPO 1982 114 p Hearing before the Subcomm. on Transportation, Aviation and Mater. of the Comm. on Sci. and Technol., 97th Congr., 2nd Sess., No. 71, 17 Feb. 1982 (GPO-91-488-VOL-1) Avail: Subcommittee on Transportation, Aviation and Materials

The status of NASA systems technology programs which provide focused technology applications principally to civil aviation is addressed in light of the cost effectiveness of NASA's partnership with the aircraft industry and the economic impact of the reduction of NASA's roll in promoting advanced aeronautical technology. Progress made in research and technology programs encompassing aerodynamics, propulsion, materials and structures as well as controls and guidance, human factors, and low speed and high speed aircraft technology is reported. The six elements of the Aircraft Energy Efficiency program are highlighted. These are: engine component improvement, energy efficient engine, advanced turboprop, energy efficient transport, composite primary aircraft structures, and laminar flow control. The budget request for these programs is presented. N.W.

**N82-23072#** Arbeitsgemeinschaft Deutscher Verkehrsflughafen, Stuttgart (West Germany).

### **PRESENT AND FUTURE ENERGY CONSUMPTION FOR PASSENGER TRANSPORTATION IN GERMANY [ENERGIEVERBRAUCH IM PERSONENFERNVERKEHR DER BUNDESREPUBLIK DEUTSCHLAND IN GEGENWART UND ZUKUNFT]**

M. KUHNE and U. WOLFFRAM 1981 142 p refs In GERMAN

(ISBN-3-87977-051-4) Avail: NTIS HC A07/MF A01

Passenger transportation in Germany was investigated in order to determine real energy consumption. For typical passengers, energy consumption for overland travel and charter flights was studied. The energy needed for air traffic was compared with that for transportation overland (railway, car, bus), taking into account transportation to the airport or railway station. Transportation makes up about 17% of German primary energy consumption, i.e., road traffic 14%, railway traffic 1.6%, and air traffic 1%. Specific energy consumption (overland travel) of intercity trains, airplanes and cars is in the proportion 1.0 to 3.7 to 4.0 (1980) and is expected to be 1 to 2.4 to 3.1 by the year 2000. For holiday trips, specific energy consumption for bus, train, car and airplane travel is in the proportion 1.0 to 1.4 to 3.6 to 3.4 (1980) and is expected to be 1 to 1.4 to 2.5 to 2.9 by 2000. Author (ESA)

**N82-23373#** Solar Turbines International, San Diego, Calif.

### **HIGH TEMPERATURE METALLIC RECUPERATOR Annual Report, May 1980 - Apr. 1981**

M. E. WARD, N. G. SOLMON, and C. E. SMELTZER Jun. 1981 130 p refs Sponsored by Gas Research Inst. (PB82-141102; SR81-R-4861-15; GRI-80/0074) Avail: NTIS HC A07/MF A01 CSCL 13A

An industrial 4.5 MM Btu/hr axial counterflow recuperator, fabricated to deliver 1600 F combustion air, was designed to handle rapid cyclic loading, a long life, acceptable costs, and a low maintenance requirement. A cost benefit analysis of a high temperature waste heat recovery system utilizing the recuperator and components capable of 1600 F combustion air preheat shows that this system would have a payback period of less than two years. Fifteen companies and industrial associations were

interviewed and expressed great interest in recuperation in large energy consuming industries. Determination of long term environmental effects on candidate recuperator tubing alloys was completed. Alloys found to be acceptable in the 2200 F flue gas environment of a steel billet reheat furnace, were identified.

GRA

**N82-23533#** Mueller Associates, Inc., Baltimore, Md.

### **A FLEET MANAGER'S GUIDE TO VEHICLES FOR VALID RESULTS**

Feb. 1981 39 p refs Presented at DOE Conf. on Fleet Use of Unique Automotive Fuels, San Antonio, Tex., 13-14 Aug. 1980 Sponsored by DOE

(DOE/CS-56051/04) Avail: NTIS HC A03/MF A01

While the measurement of acquisition, maintenance, and insurance costs is relatively straightforward and amenable to standard cost accounting procedures, the measurement and extrapolation of fuel use (and costs) from limited test programs involves many subtleties which, if ignored, can lead to erroneous conclusions. Information is presented to aid the automotive fleet manager in setting up a test program to measure and estimate fleet fuel economy and fuel use. Other areas of economic interest may also be added. The collection and analysis of data from various tests, and methods for reporting results and performing life cycle cost analyses are included. A.R.H.

**N82-23682#** Pacific Northwest Lab., Richland, Wash.

### **FUEL CONSERVATION BY THE APPLICATION OF SPILL PREVENTION AND FAIL-SAFE ENGINEERING (A GUIDELINE MANUAL) Final Report**

J. L. GOODIER, R. J. SICLARI, and P. A. GARRITY Jun. 1981 345 p refs

(Contract AC06-76-RL0-1830; EY-76-C-06-1830)

Avail: NTIS HC A15/MF A01

Spill prevention procedures are provided for maintaining a spill free plant during the transportation, transfer, storage and processing of petroleum products. The manual can be used to prevent spills of materials other than fuel oil. Special emphasis is given to failsafe engineering as an approach to preventing spills from the predominant cause-human failure. S.L.

**N82-23734#** Department of Energy, Washington, D. C. Office of Facility Planning and Support.

### **ENERGY CONSERVATION IN BUILDINGS AND GENERAL OPERATIONS Annual Report**

Jan. 1981 26 p

(DE82-002723; DOE/MA-0004) Avail: NTIS HC A03/MF A01

An In-house Energy Management program designed to reduce energy consumption and increase energy efficiency in buildings and general operations facilities, is described. The major goals of the program are: retrofit of all buildings to improve energy efficiency and assure minimum life cycle costs by 1990; reduction, in existing DOE buildings by 20% and in new DOE buildings by 45%, of average energy use per gross square foot by FY 1985, as compared to FY 1975 usage; reduction of petroleum-based fuels use by 30% by FY 1985, as compared to FY 1975 usage; and discontinuation of petroleum in major fuel burning installations by FY 2000; discontinuation of the use of natural gas in MFBI by FY 2000; and implementation of cost effective solar and other renewable energy systems. DOE's active program in energy conservation surveys and studies, retrofit and maintenance improvements, procurement of fuel efficient vehicles, driver training, and employee awareness enabled the Department to reduce its energy consumption in FY 1980 by approximately 14%, as compared to the embargo year of 1973. DOE

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**N82-23754#** Department of Energy, Washington, D. C. Energy Information Administration.

### **SHORT-TERM ENERGY OUTLOOK: METHODOLOGY**

C. CORNETT, D. PAXSON, A. P. REZNEK, C. CHU, S. SITZER, N. GAMSON, J. P. CHILDRESS, S. PAUL, H. WEIGEL, S. SUTTON et al. May 1981 128 p 2 Vol.

(DE82-002940; DOE/EIA-0202/7-2) Avail: NTIS HC A07/MF A01

Detailed discussions of forecasting methodology and analytical topics concerning short-term energy markets are presented. Major assumptions necessary to make the energy forecasts are also discussed. Supplementary analyses of topics related to short-term energy forecasting are also given. The discussions relate to the forecasts prepared using the short term integrated forecasting system. This set of computer models uses data from various sources to develop energy supply and demand balances. Econometric models used to predict the demand for petroleum products, natural gas, coal, and electricity are discussed. Price prediction models are also discussed. The role of oil inventories in world oil markets is reviewed. Various relationship between weather patterns and energy consumption are discussed. DOE

**N82-23759#** Board of Chosen Freeholders, Woodbury, N.J. **FEASIBILITY STUDY: CODISPOSAL WITH ENERGY RECOVERY FROM WASTEWATER SLUDGE AND MUNICIPAL REFUSE. PHASE 2, GLOUCESTER COUNTY, NEW JERSEY**

Jul. 1981 157 p refs

(Contract DE-AC01-79CS-20212)

(DE82-000882; DOE/CS-20212/1) Avail: NTIS HC A08/MF A01

The feasibility of thermal reduction of dewatered sludge and mixed municipal refuse with steam recovery for generation of electricity is investigated. The Gloucester County Utilities Authority wastewater treatment complex would produce the sludge and benefit from the generated electricity from a waste to energy system located on adjacent property. DOE

**N82-23761#** General Electric Co., Washington, D. C. **ENERGY USE IN OFFICE BUILDINGS: ANALYSIS OF USE IN A RANDOM SAMPLE OF 1100 BUILDINGS**

Jun. 1981 106 p refs

(Contract DE-AC01-79CS-20189)

(DE82-000518; DOE/CS-20189/3) Avail: NTIS HC A06/MF A01

The collection and analysis of an energy use data base obtained from a sample of approximately 1100 randomly selected major office buildings located in 20 US cities are reported. Information on the collection of the data and on the characteristics of the buildings for which data were gathered is given. A tabular analysis of the energy consumption data is performed by census division, fuel type, building age, height, downtown/suburban location, and class of space. The data base (denoted as the 20-city data base) is compared to the data base obtained from the experience exchange report denoted as the EER office building sample. Both data bases were for the year 1977. Tables present the comparison of the two data bases. In general the EER office building sample buildings used more energy than did the buildings in the 20-city data base: i.e., the buildings in the experience exchange report are biased towards higher energy use buildings. Furthermore, the EER office building sample has proportionally more gas and steam buildings than does the random sample. On a national basis the EER office building sample buildings used approximately 10% more energy than did the buildings in the 20-city data base in 1977.

DOE

**N82-23763#** New England Congressional Inst., Washington, D.C.

### **ENERGY IN NEW ENGLAND: TRANSITION TO THE 80'S**

R. KATZ, L. PAWLICK, and B. SPENCER 22 Jun. 1981 74 p refs

(DE82-000234; DOE/TIC-2000234) Avail: NTIS HC A04/MF A01

Activities in New England which result in more efficient consumption of energy are discussed. Change in aggregate energy demand since the oil embargo, energy use and the regional economy, incentives for conservation, and decline in electricity growth are also discussed. The contributions made by wood products, hydroelectric power, solid waste, solar, wind, alcohol fuels, peat, and tidal power are disclosed. Changes in consumption of individual conventional energy products (petroleum, natural gas, nuclear power, coal, purchased electricity) and activity currently underway in the conventional fuel area are summarized. DOE

**N82-23769#** Applied Forecasting and Analysis, Inc., Los Angeles, Calif.

### **DEMAND 80/81: FORECASTS OF ENERGY CONSUMPTION TO THE YEAR 2000. VOLUME 1: FORECASTS AND DESCRIPTION OF THE FORECASTING MODEL Final Report**

A. M. BORGES and R. T. CROW Oct. 1981 120 p refs 2 Vol.

(Contract EPRI PROJ. 1747-1)

(DE82-900871; EPRI-EA-2078-VOL-1) Avail: NTIS HC A06/MF A01

National forecasts of end use consumption of electricity, liquid hydrocarbons, gaseous hydrocarbons, and coal are presented. The forecasts are based on an econometric model whose equations represent energy consumption of each form of energy in each end use sector. Each forecast is conditional upon a common forecast of long run economic growth, coupled with a scenario concerning energy prices and conservation policy. The scenarios are composed of four alternative sets of assumptions about energy prices and three alternative sets of assumptions on conservation policy. DOE

**N82-23770#** Applied Forecasting and Analysis, Inc., Los Angeles, Calif.

### **DEMAND 80/81: FORECASTS OF ENERGY CONSUMPTION TO THE YEAR 2000. VOLUME 2: APPENDIXES Final Report**

A. M. BORGES, C. M. BOYCE, and R. T. CROW Oct. 1981 203 p 2 Vol.

(Contract EPRI PROJ. 1747-1)

(DE82-900870; EPRI-EA-2078-VOL-2) Avail: NTIS HC A10/MF A01

The forecasts cover each sector of the economy and are conditional upon alternative assumptions concerning national economic growth, energy prices, other prices, and conservation policy. The forecasts also include forms of energy other than electricity to provide a comprehensive energy picture. Although the forecasts proceed through time in one-year increments, their primary focus is on the period from 1985 to 2000. DOE

**N82-23778#** Department of Energy, Washington, D. C. Office of Energy Markets and End Use.

### **RESIDENTIAL ENERGY CONSUMPTION SURVEY (RECS): NATIONAL INTERIM ENERGY CONSUMPTION SURVEY, 1978-1979. HOUSEHOLD MONTHLY ENERGY CONSUMPTION AND EXPENDITURES. USER'S GUIDE**

P. WINDELL Aug. 1981 60 p

(PB82-114919; DOE/DF-81/027A) Avail: NTIS HC A04/MF A01 CSCL 10A

Technical specifications and basic information necessary for the appropriate use of the machine readable magnetic tapes containing data from the National Interim Energy Consumption Survey. Household monthly energy consumption and expenditures records of the residential energy consumption survey are provided. Included are an overview of the Residential Energy Consumption Survey (RECS) effort as a whole and a brief description of this administration of the RECS, the National Interim Energy

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Consumption Survey. Technical specifications for reading the tapes and descriptions of the contents of each of the files contained on the tape are given. T.M.

**N82-23779#** Department of Energy, Washington, D. C. Office of Energy Markets and End Use.  
**RESIDENTIAL ENERGY CONSUMPTION SURVEY (RECS): NATIONAL INTERIM ENERGY CONSUMPTION SURVEY, 1978-1979, HOUSEHOLD MONTHLY ENERGY CONSUMPTION AND EXPENDITURES. SHOPPER'S GUIDE**  
P. WINDELL Aug. 1981 27 p  
(PB82-114927; DOE/DF-81/027B) Avail: NTIS HC A03/MF A01 CSCL 10A CSCL 10A

The data from the National Interim Energy Consumption Survey (NIECS) is available to the public on machine readable magnetic tapes. Brief overviews of the Residential Energy Consumption Survey as a whole and of the NIECS in particular is a brief description of each of the files included in this tape, and a list of the variables in the data set are included. A copy of the fuel supplier record form used to collect consumption and expenditure data for each of the sample households is also included. T.M.

**N82-23780#** D'Appolonia (E.) Consulting Engineers, Inc., Pittsburgh, Pa.  
**GEOHERMAL ENERGY MARKET STUDY ON THE ATLANTIC COASTAL PLAIN: OCEAN CITY, MARYLAND GEOTHERMAL ENERGY EVALUATION**  
C. E. SCHUBERT Aug. 1981 53 p refs Prepared for Applied Physics Lab, Laurel, Md.  
(Contract DOE-EX-78-A-38-1008; DE-AI01-79ET-27025)  
(PB82-123050; JHU/APL/QM-81-109) Avail: NTIS HC A04/MF A01 CSCL 13A

Thermal energy benefits for a proposed recreational complex are discussed. Resource potential, resource utilization, costs, economics, feasibility are considered. An operation scenario is included. N.W.

**N82-23782#** National Bureau of Standards, Washington, D.C. National Engineering Lab.  
**VALIDATION AND ASSESSMENT OF ENERGY MODELS. PROCEEDINGS Final Report**  
S. I. GASS, ed. Oct. 1981 262 p refs Proceedings of symp. held at Gaithersburg, Md., 19-21 May 1980 Sponsored in part by DOE  
(PB82-123951; NBS-SP-616; LC-81-6000087) Avail: NTIS HC A12/MF A01 CSCL 10A

The symposium was organized with a two fold agenda to summarize the recent ideas and advances of model validation and assessment that have been applied to DOE energy models, and to hold workshops on key open questions that are of concern to the validation and assessment research community. Speakers addressed current and future practices, the EIA model validation program, model structure and data, and model credibility. Full day workshop sessions were held on the following topics: validating composite models, the measurement of model confidence, model structure and assessment, sensitivity and statistical analysis of models, and model assessment methodologies. GRA

**N82-23783#** California Energy Commission, Sacramento.  
**ENERGY TOMMORROW: CHALLENGES AND OPPORTUNITIES FOR CALIFORNIA Biennial Report, 1981**  
Jul. 1981 216 p refs  
(PB82-117821; CAEC-75) Avail: NTIS HC A10/MF A01 CSCL 10A

The California Energy Commission presents its views on the critical energy issues for California in the next twenty years along with its official electricity demand forecast and assessments of other energy demand growth. Demand is compared to estimates of the potential contributions of conservation and various conventional and alternative energy supply projects. California's overdependence on oil is discussed and options for reducing petroleum use, particularly in the transportation sector were examined. The result is a series of policy recommendations for

directing public and private investments into a diversity of energy options and for spreading the benefits and costs of these options broadly and fairly among California's citizens. T.M.

**N82-23784#** Department of Energy, Washington, D. C. Energy Information Administration.  
**STATE ENERGY DATA REPORT: STATISTICAL TABLES AND TECHNICAL DOCUMENTATION 1960 THROUGH 1979**  
Sep. 1981 530 p  
(PB82-119470; DOE/DF-81/037A) Avail: NTIS HC A23/MF A01 CSCL 10A

All the data of the State Energy Data System (SEDS) is given. The data is used to estimate annual energy consumption by principal energy sources (coal, natural gas, petroleum, electricity), by major end-use sectors (residential, commercial, industrial, transportation, and electric utilities), and by state (50 states, the District of Columbia, and the United States). Data is organized alphabetically by energy source (fuel), by end-use sector or energy activity, by type of data and by state. Twenty data values are associated with each fuel-sector-type state grouping representing positionally the years 1960 through 1979. Data values in the file are expressed either as physical units, British thermal units, physical to Btu conversion factors or share factors. GRA

**N82-23785\*#** National Bureau of Standards, Washington, D.C. Center for Materials Science.

**DETECTION, DIAGNOSIS AND PROGNOSIS: CONTRIBUTION TO THE ENERGY CHALLENGE: PROCEEDINGS OF THE MEETING OF THE MECHANICAL FAILURES PREVENTION GROUP Final Report**

T. R. SHIVES, ed. and W. A. WILLARD, ed. Oct. 1981 341 p refs Conf. held in Santa Monica, Calif., 7-9 Oct. 1980 Sponsored in part by NASA, ONR, and Naval Air Systems Command (NASA-CR-168713; NAS 1.26:168713; PB82-120304; NBS-SP-622; LC-81-600125) Avail: NTIS HC A15/MF A01 CSCL 10A

The contribution of failure detection, diagnosis and prognosis to the energy challenge is discussed. Areas of special emphasis included energy management, techniques for failure detection in energy related systems, improved prognostic techniques for energy related systems and opportunities for detection, diagnosis and prognosis in the energy field. GRA

**N82-23791#** Mound Lab., Miamisburg, Ohio.  
**POTABLE WATER STANDARDS PROJECT Final Report**  
C. E. STYRON and H. E. MEYER 7 Apr. 1981 212 p refs  
(Contract DE-AC04-76DP-00053; EY-76-C-04-0053)  
(MLM-2819) Avail: NTIS HC A10/MF A01

The pollution of drinking water with tritium discharges from a nuclear power plant is discussed. Waste disposal practices are described. Management of tritiated wastes is discussed. Approaches to resolving the tritium pollution problem are discussed in light of Federal pollution standards that are now being exceeded. The effects on the local aquifer and proposed efforts to clean it up are discussed. R.J.F.

**N82-23794#** Department of Energy, Washington, D. C.  
**ENVIRONMENTAL READINESS DOCUMENT. INDUSTRIAL PROGRAMS, FISCAL YEAR 1980**  
Feb. 1981 175 p refs  
(DOE/ERD-0031) Avail: NTIS HC A08/MF A01

The environmental readiness of nine technologies under development are discussed. The technologies are: heat pump grain drying, blended cement, acetylene from coal, polypropylene waste to fuel oil, foam drying textiles, microwave and vacuum drying, fuel saving paint plant, new fertilizer process, and high performance forge furnace. Environmental considerations relevant to each technology are discussed. Pollution control, occupational health and safety, and conformity to environmental regulations are discussed. R.J.F.

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**N82-23798#** Bioassay Systems Corp., Woburn, Mass.  
**DEVELOPMENT OF ENVIRONMENTAL ASSESSMENT SCREENING CRITERIA FOR COAL-CONVERSION SOLID WASTES Technical Progress Report, 1 Jul. - 30 Sep. 1981**  
Z. REUVENY and D. M. HANSON Sep. 1981 11 p refs  
(Contract DE-AC22-80PC-30098)  
(DE82-000751; DOE/PC-30098/T3) Avail: NTIS HC A02/MF A01

The preparation of extracts from each of the three waste test samples from the Ft. Lewis solvent refined coal 2 pilot plant was completed as well as most of the health and ecological tests which comprise the test battery. The extraction procedures and the tests performed on the extracts are being evaluated and reassessed. DOE

**N82-23806#** Combustion Engineering, Inc., Windsor, Conn.  
**ENVIRONMENTAL REPORT: COMBUSTION ENGINEERING/GULF STATES UTILITIES COMPANY FUEL GAS DEMONSTRATION PLANT, WESTLAKE, LOUISIANA Final Report**  
Sep. 1981 237 p refs Prepared in cooperation with Radian Corp., Austin, Tex.  
(Contract DE-AC02-80CH-10047)  
(DE82-004141; DOE/CH-10047/1) Avail: NTIS HC A11/MF A01

The environmental impact of the construction and operation of a coal gasification demonstration plant within the confines of an existing power plant site is predicted. Solid waste disposal is predicted to require less than 60 acres of land within the plant boundary over a 20 year period. Compared to the ongoing activities at the power plant site, the demonstration plant will have a very small impact. Impacts beyond plant boundaries will be very slight. No significant environmental impacts are anticipated to result from the construction, operation, or final disposition of the demonstration plant. DOE

**N82-23811#** Oak Ridge National Lab., Tenn.  
**ANALYSIS OF ENVIRONMENTAL ISSUES RELATED TO SMALL-SCALE HYDROELECTRIC DEVELOPMENT. 5: INSTREAM FLOW NEEDS FOR FISHERY RESOURCES**  
J. M. LOAR and M. J. SALES Oct. 1981 135 p refs  
(Contract W-7405-ENG-26)  
(DE82-000901; ORNL/TM-7861) Avail: NTIS HC A07/MF A01

The growing recognition nationwide of the importance of protecting instream uses of water has coincided with the recent emphasis on the development of small-scale hydropower resources. The issue of instream flow maintenance in hydropower development is essentially a problem of evaluating the effects of planned modifications in hydrologic patterns. Because hydroelectric projects can alter natural flow regimes on both spatial and temporal scales, downstream water users, the aquatic ecosystem, and primarily fish, can be adversely affected. Numerous methods which differ in their use of hydrologic records, hydraulic simulation techniques, and habitat rating criteria were developed to assess the effects of stream flow regulation on aquatic biota and to provide instream flow recommendations. Consequently, guidance is needed to ensure that the most appropriate methods are selected for instream flow assessments at small-scale hydroelectric sites. DOE

**N82-23813#** Environmental Protection Agency, Ann Arbor, Mich.  
Control Technology Assessment and Characterization Branch.  
**MOBILE SOURCE EMISSIONS OF FORMALDEHYDE AND OTHER ALDEHYDES**  
P. M. CAREY May 1981 37 p refs  
(PB82-118159; EPA/AA/CTAB/PA/81-11) Avail: NTIS HC A03/MF A01 CSCL 07D

The available vehicular aldehyde studies were summarized in an attempt to characterize aldehyde emissions from motor vehicles. Topics covered in these studies include aldehyde emission factors for unmodified and malfunction vehicle engine configurations, effects of fuel, mileage accumulation and temperature variations and aldehyde emissions from Diesel-equipped vehicles equipped

with prototype light-duty Diesel oxidation catalysts. Thus, it was possible to obtain aldehyde data for standard conditions and for a variety of operating conditions. The Federal test procedure (FTP) was used for the light-duty vehicles and the 13-mode test procedure for the heavy-duty engines. The 2, 4 dinitrophenylhydrazine (DNPH) procedure was used for the sampling and analysis of the aldehydes. GRA

**N82-23821#** Environmental Protection Agency, Ann Arbor, Mich.  
Control Technology Assessment and Characterization Branch.  
**BRIEF SYNOPSIS OF EPA OFFICE OF RESEARCH AND DEVELOPMENT AND THE HEALTH EFFECTS INSTITUTE MOBILE SOURCE WORK**  
May 1981 27 p refs  
(PB82-124421; EPA/AA/CTAB/PA/81-10) Avail: NTIS HC A03/MF A01 CSCL 13B

The work in progress by ORD, the pertinent results, and future work planned by ORD are discussed. Some of the important areas mentioned are: chemical characterization work, development of method to collect gas-phase hydrocarbons in diesel exhaust, effect of NO<sub>2</sub> in mutagen artifact generation, study of filter efficiency, and identification of types of compounds responsible for Ames test activity in diesel particles. T.M.

**N82-23826#** Environmental Protection Agency, Ann Arbor, Mich.  
Control Technology Assessment and Characterization Branch.  
**THE DETERMINATION OF A RANGE OF CONCERN FOR MOBILE SOURCE EMISSIONS OF SULFURIC ACID**  
C. A. HARVEY and R. J. GARBE Aug. 1981 29 p refs  
(PB82-117870; EPA/AA/CTAB/PA/81-21) Avail: NTIS HC A03/MF A01 CSCL 13B

In light of the action called for in section 202(a)(4) of the Clean Air Act (CAA) and due to a concern within industry as to what emission levels will be used as the basis for the evaluation of current and future technologies, a methodology was developed in order to bracket a range of concern for various unregulated pollutants. The efforts from two EPA contracts are coordinated in order to use this methodology specifically for an evaluation of sulfuric acid. GRA

**N82-24051#\*** National Aeronautics and Space Administration.  
Langley Research Center, Hampton, Va.  
**GUIDE TO THE EVALUATION OF HUMAN EXPOSURE TO NOISE FROM LARGE WIND TURBINES**  
D. G. STEPHENS, K. P. SHEPHERD (Bionetics Corp., Hampton, Va.), H. H. HUBBARD (College of William and Mary, Newport News, Va.), and F. W. GROSVELD (Bionetics Corp., Hampton, Va.) Mar. 1982 71 p refs  
(Contract NAS1-14970; NAG1-166)  
(NASA-TM-83288; NAS 1.15:83288) Avail: NTIS HC A04/MF A01 CSCL 20A

Guidance for evaluating human exposure to wind turbine noise is provided and includes consideration of the source characteristics, the propagation to the receiver location, and the exposure of the receiver to the noise. The criteria for evaluation of human exposure are based on comparisons of the noise at the receiver location with the human perception thresholds for wind turbine noise and noise-induced building vibrations in the presence of background noise. B.W.

**N82-24391#** California Univ., Berkeley. Lawrence Berkeley Lab.  
Energy and Environment Div.  
**CALIFORNIA EXPERIENCE WITH ENERGY CONSERVATION STANDARDS FOR BUILDINGS**  
R. FEINBAUM May 1981 142 p refs  
(Contract W-7405-ENG-48)  
(DE81-000972; LBL-12731) Avail: NTIS HC A07/MF A01

Results of California's development and implementation study of its Title 24 Energy Conservation standards are presented. The Title 24 standards are compared with the National Building Energy Performance Standards. Results show implementation difficulties occurred in starting up the program and information dissemination. Local enforcement practices proved variable and ambiguities in

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the standards created special problems for building officials. These problems are discussed in detail. Innovative approaches such as use of computer calculations proved difficult for approval and this problem is discussed. Attitudes toward standards are described. Details on the structure of the home building industry in California are given. Measures taken by the California Energy Commission to review and update the standards are described. DOE

**N82-24648\*#** Engelhard Industries, Inc., Edison, N.J.  
**DEVELOP AND TEST FUEL CELL POWERED ON-SITE INTEGRATED TOTAL ENERGY SYSTEMS: PHASE 3: FULL-SCALE POWER PLANT DEVELOPMENT Quarterly Report, Aug. - Oct. 1981**

28 Apr. 1982 59 p refs  
(Contract DEN3-241; DE-AI-01-80ET-17088)  
(NASA-CR-165568; DOE/NASA/0241-3; NAS 1.26:165568; QR-3)  
Avail: NTIS HC A04/MF A01 CSCL 10B

The development of a commercially viable and cost-effective phosphoric acid fuel cell powered on-site integrated energy system (OS/IES) is described. The fuel cell offers energy efficiencies in the range of 35-40% of the higher heating value of available fuels in the form of electrical energy. In addition, by utilizing the thermal energy generated for heating, ventilating and air-conditioning (HVAC), a fuel cell OS/IES could provide total energy efficiencies in the neighborhood of 80%. Also, the Engelhard fuel cell OS/IES offers the important incentive of replacing imported oil with domestically produced methanol, including coal-derived methanol.

T.M.

**N82-24661#** Argonne National Lab., Ill.  
**DISTRIBUTED THERMAL ENERGY STORAGE IN THE RESIDENTIAL SECTOR: COMMERCIALIZATION READINESS ASSESSMENT AND IMPLEMENTATION STRATEGY**

R. F. GIESE In Courtesy Associates, Inc. Proc. of the DOE Thermal and Chem. Storage Ann. Contractor's Rev. Meeting p 31-32 Mar. 1981

Avail: NTIS HC A16/MF A01

Significant national benefits can result from the use of customer-sides-of-the-meter thermal energy storage (TES). It appears that TES for residential space heating and hot water heating can capture a market large enough to yield annual oil savings of approximately 80 million barrels (0.3 quads) by the year 2000. The readiness of each of three candidate TES systems for near-term commercialization was examined. It was concluded that of these, TES for residential space and hot water heating are technically and economically ready for commercialization. T.M.

**N82-24693#** TRW, Inc., McLean, Va. Energy Systems Planning Div.

**A COST-EFFECTIVENESS EVALUATION OF CHEMICAL HEAT PUMPS**

W. R. STANDLEY, R. GORMAN, P. S. MORITZ, and T. J. OGORMAN In Courtesy Associates, Inc. Proc. of the DOE Thermal and Chem. Storage Ann. Contractor's Rev. Meeting p 159-162 Mar. 1981

Avail: NTIS HC A16/MF A01

Chemical heat pump technologies are compared with a baseline of existing HVAC technologies and a set of emerging competitive technologies. The basis for comparison is system cost effectiveness in one or more specific applications, with leveled annual cost taken as the measure of cost effectiveness. The specific applications are a residential building and a commercial building, each requiring HVAC services. An industrial process-heat upgrading application is also included. For each system, the net consumption of fossil fuel resources is evaluated, and environmental/safety aspects identified. Author

**N82-24727#** Pacific Northwest Lab., Richland, Wash.  
**OVERVIEW OF ENERGY-CONSERVATION RESEARCH OPPORTUNITIES. EXECUTIVE SUMMARY**

W. J. HOPP, S. G. HAUSER, G. J. HANE, W. E. GURWELL, S. P. BIRD, W. C. CLIFF, R. E. WILLIFORD, T. A. WILLIAMS, and W. B. ASHTON Nov. 1981 21 p refs  
(Contract DE-AC06-76RL-01830)

(DE82-004031; PNL-3944-EX-SUMM) Avail: NTIS HC A02/MF A01

Research opportunities that are important to developing advanced technologies for efficient energy use are presented. A wide array of attractive technical areas from which specific research and development programs could be implemented are described. Research areas are presented for potential application in each of the major energy end-use sectors. The analysis employs a systematic process for both identifying and screening candidate energy conservation research areas. Aggregate energy consumption was reviewed and explicit criteria were employed to evaluate the technology research areas. DOE

**N82-24728#** Pacific Northwest Lab., Richland, Wash.  
**BUILDING AND OCCUPANT CHARACTERISTICS AS DETERMINANTS OF RESIDENTIAL ENERGY CONSUMPTION**

L. A. NIEVES and A. I. NIEVES Oct. 1981 82 p

(Contract DE-AC06-76RL-01830)

(DE82-002417; PNL-4012) Avail: NTIS HC A05/MF A01

The probable effects of building energy performance standards on energy consumption were studied. Observations of actual residential energy consumption that could affirm or disaffirm consumption estimates of the Department of Energy's 2.0A simulation model were obtained. Home owner's conservation investments and home purchase decisions were investigated. The investigation of determinants of household energy consumption is described. The underlying economic theory and its implications are given as well as a description of the data collection procedures, of the formulation of variables, and then of data analysis and findings. The assumptions and limitations of the energy use projections generated by the DOE 2.0A model are discussed. Actual electricity data for the houses are then compared with results of the simulation. DOE

**N82-24731#** Oak Ridge National Lab., Tenn.  
**ENERGY CONSUMED IN 2010 BY AN ENERGY-EFFICIENT BUILDING SECTOR**

G. D. PINE Nov. 1981 71 p refs

(Contract W-7405-ENG-26)

(DE82-003520; ORNL-5772) Avail: NTIS HC A04/MF A01

The minimum practical energy consumption in the building sector in the year 2010 if an aggressive program of efficiency improvement were implemented was estimated. For the case of a 2% annual growth rate in real gross national product, an 0.8% annual growth in population, and a quadrupling of real fuel prices relative to the 1975 prices, we concluded that end-use fuel consumption by the building sector could be reduced to 7.7 exajoule (EJ) in 2010 compared to 18.0 EJ in 1977. This could be accomplished by using technologies that are available today or can be predicted with a high level of confidence to be available in 2010. No technological breakthroughs would be required, and no sacrifice in amenities would be necessary. Indeed, the real standard of living would improve. Furthermore, the results were only slightly sensitive to fuel prices; most efficiency improvements were attractive economically at today's fuel prices or at prices only slightly higher. DOE

**N82-24842#** Societe Nationale Industrielle Aerospatiale, Toulouse (France). Service Controle Automatique du Vol.

**FLIGHT MANAGEMENT COMPUTER**

J. GROSSIN 7 Jan. 1982 26 p In FRENCH Presented at Soc. des Electriciens et des Radioelectriciens (SEE), Nice, 26 Nov. 1981 Submitted for Publication

(SNIAS-821-111-110) Avail: NTIS HC A03/MF A01

Ways in which automatic flight control can reduce fuel consumption were investigated. Three domains were identified:

(1) thrust optimization, (2) optimization of in-flight aerodynamic configuration, and (3) flight plan optimization. The use of flight management computers to achieve these goals is discussed and recently developed equipment is depicted. System design and functions are explained. The choice of performance optimization criteria (cost index) is considered. How a flight management computer deals with horizontal navigation is treated as an example. Author (ESA)

**N82-25110\*#** Jet Propulsion Lab., California Inst. of Tech., Pasadena.

**POTENTIAL REDUCTION OF DSN UPLINK ENERGY COST**

S. DOLINSKY and N. F. DEGROOT *In its* The Telecommun. and Data Acquisition Rept. p 151-166 15 Apr. 1982 refs  
 Avail: NTIS HC A09/MF A01 CSCL 09C

DSN Earth stations typically transmit more power than that required to meet minimum specifications for uplink performance. Energy and cost savings that could result from matching the uplink power to the amount required for specified performance are studied. The Galileo mission was selected as a case study. Although substantial reduction in transmitted energy is possible, potential savings in source energy (oil or electricity) savings are much less. This is because of the rising inefficiency in power conversion and radio frequency power generation that accompanies reduced power output. S.L.

**N82-25239\*#** Hampton Inst., Va.  
**COST AND FUEL CONSUMPTION PER NAUTICAL MILE FOR TWO ENGINE JET TRANSPORTS USING OPTIM AND TRAGEN Final Report**

J. F. WIGGS 30 Apr. 1982 280 p  
 (Contract NAG1-69)  
 (NASA-CR-168973; NAS 1.26:168973) Avail: NTIS HC A13/MF A01 CSCL 01C

The cost and fuel consumption per nautical mile for two engine jet transports are computed using OPTIM and TRAGEN. The savings in fuel and direct operating costs per nautical mile for each of the different types of optimal trajectories over a standard profile are shown. S.L.

**N82-25336#** Council for Scientific and Industrial Research, Pretoria (South Africa).

**ON THE PROCESSING OF MANGANESE NODULES WITH SULPHUR CONTAINING REAGENTS**

K. H. SCHWARZ and U. BOIN 1981 15 p refs Transl. into ENGLISH from Erzmetall (West Germany), v. 27, no. 7-8, 1974 p 341-345

(CSIR-TRANS-1603) Avail: NTIS HC A02/MF A01

Sulphating/roasting of manganese nodules and leaching with SO<sub>2</sub> in a slurry are discussed as methods of breaking down manganese nodules. Roasting conditions, leaching parameters, and specific energy costs are addressed. Author

**N82-25400#** Environmental Protection Agency, Ann Arbor, Mich. Control Technology Assessment and Characterization Branch.

**CURRENT STATUS OF EPA OFFICE OF MOBILE SOURCE AIR POLLUTION CONTROL CHARACTERIZATION PROJECTS: SUMMARY**

T. M. BAINES Aug. 1981 68 p refs  
 (PB82-105909; EPA/AA/CTAB/PA/81-18) Avail: NTIS HC A04/MF A01 CSCL 21D

EPA-OMSAPC is conducting a thorough characterization of unregulated emissions on a variety of current and prototype engines. Extensive work is also underway to see how various fuel parameters affect regulated and unregulated emissions. This latter work includes projects on alternate fuels such as methanol as well as fuels derived from coal or oil shale. GRA

**N82-25632** International Institute for Applied Systems Analysis, Laxenburg (Austria).

**THE ENERGY SUPPLY MODEL MESSAGE**

L. SCHRATTENHOLZER Dec. 1981 41 p refs  
 (RR-81-31; ISBN-3-7045-0024-0) Avail: Issuing Activity

A dynamic linear programming model that minimizes the total discounted costs of supplying a given set of energy demands over a given time is introduced. It balances secondary energy demand, disaggregated into sectors and exogenous to the model, with primary energy supply, a set of resource availabilities disaggregated into an optional number of cost categories by choosing from a set of energy conversion technologies. Model constraints reflect the limited speed of build up of technologies, the limited annual availability of resources, and technological relationships. The model defines load regions (e.g., for electricity demand), distinguishes between indigenous and imported resources, and optionally includes environmental impacts in the objective function. It can be applied to global or smaller scale scenarios. Author (ESA)

**N82-25633#** Committee on Science and Technology (U. S. House).

**SUMMARY OF HEARINGS ON THE FUTURE OF THE NATION'S ENERGY UTILITIES: IMPLICATIONS FOR FEDERAL RD&D**

K. NELSON and F. J. SISSINE Washington GOP 1982 45 p Presented to The Subcomm. on Energy Develop. and Appl. of the Comm. on Sci. and Technol., 97th Congr., 2nd Sess., Mar. 1982 Prepared by the Library of Congr., Congr. Res. Serv. (GPO-91-815) Avail: Subcommittee on Energy Development and Applications

Hearings on the future of the nation's energy utilities are summarized. The future strategies of energy utilities in regard to new technologies are considered. Alternate energy technologies, conservation, diversification, deregulation, and various regulatory reforms are explored. N.W.

**N82-25634#** Committee on Science and Technology (U. S. House).

**NATIONAL ENERGY CONSERVATION POLICY UNDER THE REAGAN ADMINISTRATION: ANALYSIS OF HEARINGS ON THE DEPARTMENT OF ENERGY AUTHORIZATION FOR FISCAL YEAR 1982**

F. J. SISSINE Washington GPO 1982 58 p Presented to the Subcomm. on Energy Develop. and Appl. of the Comm. on Sci. and Technol., 97th Congr., 2nd Sess., Mar. 1982 Prepared by the Library of Congr., Congr. Res. Serv. (GPO-92-174) Avail: Subcommittee on Energy Development and Applications

Some of the major issues in energy conservation policy are summarized, including the significance of energy conservation to the national economy, foreign competition, and the prospects for increased private and local government participation. The role of the Federal Government in energy conservation, outreach, and information dissemination is discussed. R.J.F.

**N82-25650#** Mid-American Solar Energy Complex, Minneapolis, Minn.

**RESIDENTIAL CONSERVATION SERVICE PROGRAM SUPPORT Final Report**

Sep. 1981 11 p  
 (Contract DE-AC02-79CS-30150)  
 (DE82-001205; MASEC-R-81-080; A-102-4) Avail: NTIS HC A02/MF A01

Five tasks to research and prepare information for the Residential Conservation Program are described. The tasks are: preparing cost data on renewable program (specifically solar) measure; designing and publishing a consumer agency guide to advise consumers of preventive and corrective actions to take when contracting for home improvements; providing a report on financing residential energy improvements; designing solar industry information releases, specifically on solar water heaters; and preparing a brochure. DOE

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**N82-25652#** Mid-American Solar Energy Complex, Minneapolis, Minn.

### **NATIONAL SOLAR DATA NETWORK SUCCESS STORIES**

Sep. 1981 22 p

(Contract DE-AC02-79CS-30150)

(DE82-002281; MASEC-R-81-058) Avail: NTIS HC A02/MF A01

Three of the most successful applications in the MASEC reporting region are described. The three sites are the Scattergood School site in West Branch, Iowa; the South Dakota School of Mines site located at the Mount Rushmore Memorial Visitor's Center in Keystone, South Dakota, and the Telex Communications site in Blue Earth, Minnesota. The first is a school recreation center, the second a park recreation center, and the third a business. All three are active systems and each exhibits a variety of approaches to providing space and domestic water heating. The major success of each is that a substantial portion of the heating load was provided by solar energy. The success of the NSDN program is that it indicates the approaches and parts of the systems that seem to work best, so that conclusions can be made about which applications are appropriate in varying circumstances. A brief report is presented for each system explaining the system, the energy flow through the system, the total cost, and the energy saved per year. DOE

**N82-25657#** Science Research Council, Chilton (England).

### **HEAT ENERGY RECOVERY FROM DOMESTIC OUTPUT FLUIDS (HERDOF)**

F. M. RUSSELL 1981 15 p refs

(PB82-134156; RL-81-074) Avail: NTIS HC A02/MF A01 CSCL 10/C

A device incorporating energy storage is described which permits recovery of part of the available heat energy in domestic output fluids. Preliminary estimates of the potential savings indicate the device should be examined in depth and practical tests conducted. The attitude of industry to the proposed device was considered and positive recommendations were made in that area. Author (GRA)

**N82-25662#** Corps of Engineers, Buffalo, N.Y.

### **US LAKE ERIE NATURAL GAS RESOURCE DEVELOPMENT. PROGRAMMATIC ENVIRONMENTAL IMPACT STATEMENT Final Report**

A. K. MARKS, P. J. HORVATIN, P. G. LEUCHNER, and V. SAULYS Mar. 1982 240 p refs Prepared in cooperation with EPA, Chicago

(AD-A112074) Avail: NTIS HC A11/MF A01 CSCL 13B

This report comprises an abbreviated statement which incorporates by reference the Draft Programmatic statement of the same title dated November 1980 for detailed information. The document summarizes the environmental impacts associated with development of natural gas beneath U.S. waters of Lake Erie's eastern and central basins bordering the States of New York, Pennsylvania, and Ohio; provides errata and addenda to the Draft statement; and responds to comments received on the Draft Statement. Major topics of discussion include: applicability of using the Canadian Lake Erie drilling experience; establishment of a Task Force and in each state an offshore office for program coordination; waste disposal methodology; need for natural gas; the role of the International Joint Commission, the 1909 U.S. - Canada Boundary Waters Treaty, and the 1978 Water Quality Agreement; the effects of resuspending sediment; validity of using worst-case accident analysis in lieu of Canadian accident data; contingency plans and spill cleanups; the effects of polyethylene glycol chlorination; impacts on water supplies and water treatment costs; an onland alternative program; and an explanation of the reference program concept. GRA

**N82-25664#** Los Alamos Scientific Lab., N. Mex.

### **SCREENING METHODOLOGY FOR CALCULATING WORST-CASE CONCENTRATIONS DOWNWIND FROM A LARGE, ISOLATED, AIR-POLLUTANT-EMISSION SOURCE**

D. NOCHUMSON Sep. 1981 28 p refs

(Contract W-7405-ENG-36)

(DE82-002286; LA-8871-MS) Avail: NTIS HC A03/MF A01

A screening methodology to indicate whether a proposed source to be sited in a flat or high-terrain situation has the potential to violate ambient air quality standards was developed. The Gaussian plume formulation serves as a basic element of the methodology, which follows the guidelines recommended by the US Environmental Protection Agency for evaluating the air quality impacts of new stationary sources. A step-by-step procedure is given to calculate maximum ground-level concentration of pollutants under a variety of worst-case conditions that depend upon terrain conditions and the controlling air quality standards. The methodology is applied to a case study that examines the siting of generic coal-fired power plants in the West and the constraints imposed by terrain and sulfur dioxide air quality standards. DOE

**N82-25665#** Los Alamos Scientific Lab., N. Mex.

### **ENVIRONMENTAL AND RADIOLOGICAL SAFETY STUDIES. INTERACTION OF (238)PUO<sub>2</sub> HEAT SOURCES WITH TERRESTRIAL AND AQUATIC ENVIRONMENTS Progress Report, 1 Apr. - 30 Jun. 1981**

G. M. MATLACK and J. H. PATTERSON Sep. 1981 6 p

(Contract W-7405-ENG-36)

(DE82-002439; LA-8996-PR) Avail: NTIS HC A02/MF A01

The containers for (238)PuO<sub>2</sub> heat sources in radioisotope thermoelectric generators were tested. Studies of the effects on the heat source of terrestrial and aquatic environments to obtain data for design of even safer systems are described. Data from environmental chamber experiments that simulate terrestrial conditions, experiments to measure PuO<sub>2</sub> dissolution rates, soil column experiments to measure sorption of plutonium by soils, and several aquatic experiments are described. DOE

**N82-26050\*#** Jet Propulsion Lab., California Inst. of Tech., Pasadena.

### **FUTURE FUELS AND ENGINES FOR RAILROAD LOCOMOTIVES. VOLUME 2: TECHNICAL DOCUMENT**

S. G. LIDDLE 1 Nov. 1981 392 p refs

(Contract NAS7-100; DE-AI01-78CS-55151; EM-78-1-01-5151)

(NASA-CR-168983; JPL-PUB-81-101; NAS 1.26:168983) Avail:

NTIS HC A17/MF A01 CSCL 13F

The potential for reducing the dependence of railroads on petroleum fuel, particularly Diesel No. 2 was studied. The study takes two approaches: to determine the use of Diesel No. 2 can be reduced through increased efficiency and conservation, and to use fuels other than Diesel No. 2 both in Diesel and other types of engines. Synthetic hydrocarbon fuels, probably derived from oil shale, will be needed if present diesel-electric locomotives continue to be used. S.L.

**N82-26051\*#** National Aeronautics and Space Administration. Lewis Research Center, Cleveland, Ohio.

### **PRELIMINARY ANALYSIS OF A DOWNSIZED ADVANCED GAS-TURBINE ENGINE IN A SUBCOMPACT CAR**

J. L. KLANN and R. L. JOHNSEN 1982 25 p refs Presented at the 18th Joint Propulsion Conf., Cleveland, 21-23 Jun. 1982

(Contract DE-AI01-77CS-51040)

(NASA-TM-82848; E-1218; NAS 1.15:82848;

DOE/NASA/51040-40) Avail: NTIS HC A02/MF A01 CSCL 13F

Relative fuel economy advantages exist for a ceramic turbine engine when it is downsized for a small car were investigated. A 75 kW (100 hp) single shaft engine under development was analytically downsized to 37 kW (50 hp) and analyzed with a metal belt continuously variable transmission in a synthesized car. With gasoline, a 25% advantage was calculated over that of a current spark ignition engine, scaled to the same power, using the same transmission and car. With diesel fuel, a 21% advantage

was calculated over that of a similar diesel engine vehicle.

Author

**N82-26054#** Illinois Univ., Urbana-Champaign. Dept. of Civil Engineering.

**URBAN TRANSPORTATION ENERGY ACCOUNTS. VOLUME 1: PROCEDURES. VOLUME 2: CASE STUDY OF THE CHICAGO REGION Final Report, Jun. 1978 - May 1981**

D. E. BOYCE, M. C. ROMANOS, B. N. JANSON, P. PRASTACOS, M. FERRIS, and R. W. EASH (Chicago Area Transportation Study) Sep. 1981 255 p refs 2 Vol.

(Contract DOT-IL-11-0027)

(PB82-135542; UMTA-IL-11-0027-81-1) Avail: NTIS HC

A12/MF A01 CSCL 10A

Procedures for compiling a set of urban transportation energy accounts are described. These procedures deal specifically with ground-mode person travel in an urbanized area but could be generalized to other modes, commodities and regions. There are several significant differences between these procedures and methods used by other studies to estimate the energy consumption of urban person trips. First, these procedures produce estimates of both direct and indirect energy consumption. Second, energy consumption is computed by mode for each origin-destination pair of zones. Third, automobile speeds and transit vehicle occupancies calculated for individual link flows are used to estimate energy consumption per person trip over each zone to zone trip path.

GRA

**N82-26453#** Argonne National Lab., Ill. Energy and Environmental Systems Div.

**ENERGY AND MATERIALS FLOWS IN THE PRODUCTION OF PRIMARY ALUMINUM**

S. Y. SHEN Oct. 1981 52 p refs

(Contract W-31-109-ENG-38)

(DE82-005963; ANL/CNSV-21) Avail: NTIS HC A04/MF A01

The primary aluminum industry is one of the top five industrial energy users in the United States consuming about one quad annually. In 1980, for each ton of aluminum produced, an average smelting operation used about 157 million Btu of direct energy and another 70 million Btu were embodied in purchased materials. Producers employing the best practices used approximately 15% less energy per ton, or 132 million Btu of direct energy and 52 million Btu of embodied energy. These energy and materials flows are described in detail, using availability and input/output analyses and industry estimates. Energy consumption could be reduced further by developing (1) economical processes for using domestic nonbauxitic raw materials; (2) bulk alumina feeding equipment for handling more than one grade of alumina; (3) a reduction cell meter and temperature sensor for automatic control of alumina feeding and cell temperature; (4) a method for quickly and frequently measuring the NaF/AlF<sub>3</sub> ratio in a reduction cell for tighter control of electrolyte composition; and (5) a method for recovering waste heat.

DOE

**N82-26490#** Department of Energy, Washington, D. C. Office of Transportation Programs.

**SYMPOSIUM ON COMMERCIAL AVIATION ENERGY CONSERVATION STRATEGIES, PAPERS AND PRESENTATIONS**

Apr. 1981 354 p refs Symp. held in Washington, D.C., 2-3

Apr. 1981 Sponsored in part by FAA

(AD-A107106) Avail: NTIS HC A16/MF A01 CSCL 21D

The Symposium provided a forum in which representatives from DOE, FAA, National Aeronautics and Space Administration (NASA) and the aviation industry exchanged information and ideas regarding current and future efforts to conserve fuel and to promote energy conservation within the commercial aviation sector. General topics discussed included Federal and industry energy conservation programs such as flight operations, air traffic control, engineering and maintenance, and corporate management strategies. The Symposium was highlighted by a panel discussion entitled 'Energy Conservation: Where Do We Go From Here?' This report contains the papers and presentations from the Symposium.

GRA

**N82-26512#** Brookhaven National Lab., Upton, N. Y.

**FUTURE RAW MATERIALS AND ENERGY USE IN INDUSTRY: A RESEARCH AGENDA**

T. E. OHARE and F. J. SALZANO Jun. 1981 224 p Workshop Held at Reston, Va., 9-10 Nov. 1978

(Contract DE-AC02-76CH-00016)

(DE82-005975; BNL-51382) Avail: NTIS HC A10/MF A01

Research programs that might lead to a major reduction in the usage of energy and industrial raw materials in 21st century technology were discussed. The working panels considered agricultural technology; chemicals and polymers; construction; forest products, pulp and paper; glass, cement, and ceramics; information processing and machine intelligence; iron and steel processing; manufacturing; nonferrous metals processing; raw materials, exploration and extraction; technological education and engineering practices; and textiles. Research profiles and selected research projects and programs for the industries considered are included.

DOE

**N82-26513#** Brookhaven National Lab., Upton, N. Y. Dept. of Energy and Environment.

**CASE STUDY OF THE MASTIN DOUBLE-ENVELOPE HOUSE**

R. F. JONES, G. DENNEHY, H. T. GHAFFARI, and G. E. MUNSON May 1981 75 p refs

(Contract DE-AC02-76CH-00016)

(DE82-006833; BNL-51460) Avail: NTIS HC A04/MF A01

An evaluation is made of a double-envelope house of Ekose, a design built by Robert Mastin in Middletown, Rhode Island. The home has two shells with an airspace between through which air can circulate. Performance monitoring of the house in the heating season showed that the requirements for auxiliary heat are very low, about 2.1 Btu per square foot of floor space per degree-day. Design changes are identified which could reduce the heating requirement even further. This ranks the house among the most energy-efficient building designs available today. It is concluded that the low heating needs of the house are due primarily to the excellent insulative value of the double shell.

DOE

**N82-26788#** General Accounting Office, Washington, D. C. Procurement, Logistics, and Readiness Div.

**BUILDING ENERGY ANALYSIS COMPUTER PROGRAMS DEVELOPED BY FEDERAL AGENCIES: COST, USE, AND NEED**

22 Mar. 1982 13 p

(PLRD-82-47) Avail: NTIS HC A02/MF A01

The need for further government development of energy analysis computer programs is questioned, and termination of current development efforts is recommended.

Author

**N82-26789#** General Accounting Office, Washington, D. C. **MITIGATING SOCIOECONOMIC IMPACTS OF ENERGY DEVELOPMENT**

2 Mar. 1982 81 p refs

(EMD-82-13) Avail: NTIS HC A05/MF A01

Information is provided on energy resource development and the efforts of states and local communities to deal with the related social and economic impacts. Information is also provided on the range of options and resources generally available to states and local communities from local, state, industry and Federal sources to plan for an mitigate the adverse effects of energy development. Faced with reductions in Federal assistance communities will have to depend more on alternate sources.

L.F.M.

**N82-26808#** General Accounting Office, Washington, D. C. Energy and Minerals Div.

**GREATER ENERGY EFFICIENCY CAN BE ACHIEVED THROUGH LAND USE MANAGEMENT Report to the Congress**

21 Dec. 1981 59 p

(AD-A111552; GAO/EMD-82-1) Avail: NTIS HC A04/MF A01

CSCL 13B

When planning new growth and redevelopment, communities can significantly reduce energy consumption by incorporating energy-efficient land use concepts such as site and building design,

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locational planning, and higher density development. Decisionmakers, however, are reluctant to use these concepts because of major barriers such as the cost of implementing the concepts and resistance to higher density development. The Federal Government can play a role in promoting energy-efficient land use by providing guidance through its policies, supporting research and comprehensive planning, and providing needed financial incentives. Author (GRA)

**N82-26845#** Argonne National Lab., Ill.  
**ENERGY-PERFORMANCE TARGETS FOR FEDERAL BUILDINGS: RETROFIT ENERGY-TARGET BANDS FOR EXISTING POSTAL FACILITIES Final Report**

Apr. 1981 142 p refs  
(Contract W-31-109-ENG-38)

(DE82-000070; ANL/ENG-81-01) Avail: NTIS HC A07/MF A01  
A cost-effective energy performance target band was developed for postal facilities. For the retrofit energy target bands for existing postal facilities, buildings were classified into four sizes and two special use categories: namely, less than 5001 ft; 5001 to 25,000 ft; 25,001 to 100,000 ft; larger than 100,000 ft; vehicle maintenance facility (VMF) and bulk mail centers. A random statistical sample of buildings representative of the population was selected from each size category and one each from the VMF and BMC categories. Each building of the sample was then modeled and analyzed for annual energy consumption, using the DOE 2.1A computer program. For energy conservation purposes, the design parameters of existing buildings were modified, and, for each change, a computer simulation analysis was made to determine what impact the change had on the annual energy use. DOE

**N82-26848#** Department of Energy, Washington, D. C. Office of Market Analysis.

**INTERNATIONAL ENERGY INDICATORS, OCTOBER-NOVEMBER 1981**

E. ROSSI, JR., ed. 1981 28 p refs  
(DE82-004101; DOE/IA-0010/15) Avail: NTIS HC A03/MF A01

Detailed data are presented for energy indicators in tables and graphs. Specific international data are presented: world crude oil production, 1974 to July 1981; OPEC crude oil productive capacity; world crude oil and refined product inventory levels, 1975 through the first half of 1981; oil consumption in OECD countries, 1975 through the first half of 1981; USSR crude oil production, 1975 through July 1981; and free world and US nuclear electricity generation, 1973 through September 1981 and current capacity. Data presented for energy indicators in the US are: US domestic oil supply and crude oil production, 1977 through March 1981; US gross imports of crude oil and products, 1973 through August 1981; landed cost of Saudi crude oil in current and 1974 dollars; US coal trade, 1975 through July 1981; US natural gas trade, 1975 through August 1981; summary of US merchandise trade, 1977 through the first half of 1981; and the energy/gross national product ratio from 1974 through the first half of 1981. DOE

**N82-26849#** TRW, Inc., McLean, Va. Energy Engineering Div.  
**INDUSTRIAL COGENERATION OPTIMIZATION PROGRAM: A SUMMARY OF TWO STUDIES**

Aug. 1981 38 p  
(Contract W-7405-ENG-26)  
(DE82-005587; DOE/TIC-11604) Avail: NTIS HC A03/MF A01

Two industrial cogeneration optimization programs were performed to examine the economic and energy saving impacts of adding cogeneration to site specific plants in the chemical, food, pulp and paper, petroleum refining, and textile industries. Industrial cogeneration is reviewed. The two parallel ICOP studies are described. The five industrial sectors are also described, followed by highlights of each of the site specific case studies. Steam turbine cogeneration systems fired by coal or alternative fuels are generally the most attractive in terms of economic performance and oil/gas savings potential. Of the 15 cogeneration systems selected as optimum in the ICOP studies, 11 were coal or wood fired steam turbines. By contrast, gas turbines, combined

cycles, and diesel engines, which are limited to oil or gas firing, are usually less economical. DOE

**N82-26854#** California Univ., Livermore. Lawrence Livermore Lab.

**DIRECT USE OF HYDROTHERMAL ENERGY: A REVIEW OF ENVIRONMENTAL ASPECTS**

K. OBANION and D. LAYTON 28 Aug. 1981 56 p refs  
(Contract W-7405-ENG-48)

(DE82-000069; UCRL-53196) Avail: NTIS HC A04/MF A01

The potential environmental impacts of the exploration, development, and production of hydrothermal geothermal energy for direct use applications are reviewed and evaluated. Mitigation strategies and research and development needs are included. DOE

**N82-26855#** California Univ., Livermore. Lawrence Livermore Lab.

**US ENERGY FLOW, 1980**

C. K. BRIGGS and I. Y. BORG 21 Oct. 1981 15 p refs  
(Contract W-7405-ENG-48)

(DE82-002647; UCID-19227-80) Avail: NTIS HC A02/MF A01

The energy flow diagram illustrates energy sources and end uses in a single figure. The total energy consumption in 1980 was 75 quads which is 3.6% below 1979. Oil continued to be the largest single source of energy to the US by comprising 34 quads or 45% of the total used. Natural gas and coal make up 28% and 22% of the remainder. Oil imports fall 19.2% below 1979 levels resulting in a 9.2% net decrease in total oil use from 1979. There was a consequent drop in total energy consumption which was not compensated by increased overall use of either natural gas, which actually fell, or coal, which increased slightly. Coal exports increased 41%. Conversion to fuels other than oil for electrical power generation continued; coal and natural gas use for this purpose increased 7.6 and 5.5% respectively over 1979. Nuclear energy produced about the same amount of power in 1980 as in 1979. DOE

**N82-26862#** Hittman Associates, Inc., Columbia, Md.  
**DATA ON ENERGY CONSERVATION ACTIVITY IN MULTIFAMILY HOUSING Final Report**

Jul. 1981 156 p refs  
(Contract DE-AC01-79PE-70044)  
(DE82-000467; DOE/PE-70044/T4; H-C1011/007-81-1002F)  
Avail: NTIS HC A08/MF A01

A policy review to determine how the multifamily building sector is responding to market signals and to evaluate what role the federal government should play in encouraging conservation in this subsector is presented. Available data is used to assess the current status of weatherization in multifamily housing and the current trends in adding weatherization measures on using them in new construction are identified and catalogued. Data on energy practices in multifamily housing and other energy related characteristics are also identified. The purpose, the sources covered, and the findings and recommendations are described. The data are summarized. DOE

**N82-26864#** Charles River Associates, Inc., Boston, Mass.  
**USES OF THE FRS DATA BASE FOR ENERGY POLICY ANALYSIS**

15 Oct. 1981 27 p refs  
(Contract DE-AC01-81-10752)  
(DE82-001662; DOE/EIA-10752/T4; CRA-591) Avail: NTIS HC A03/MF A01

The possible uses of the financial reporting service (FRS) data base for the purposes of formulating and implementing federal energy policy federal policy regarding competition are analyzed. The potential use of the FRS system to analyze issues of competition, both at the sectoral level and across sectors are outlined and the use of the FRS system in energy policy analysis is discussed. The usefulness of firm level FRS data in determining the outcome of public policy on broad aggregates such as total exploration activity, as well as the application of FRS data in the

analysis of differential impacts of policy among firms are also considered. DOE

**N82-26873#** Air Force Engineering and Services Center, Tyndall AFB, Fla. Engineering and Services Lab.

**THE BIOLOGICAL DEGRADATION OF SPILLED JET FUELS: A LITERATURE REVIEW Final Report, Jun. - Aug. 1981**

R. E. CARLSON Oct. 1981 41 p refs

(Contract AF PROJ. 1900)

(AD-A110758; AFESC/ESL-TR-81-50) Avail: NTIS HC A03/MF A01 CSCL 06F

Biodegradation of many of the components of Air Force fuels does occur, although most studies have been done under laboratory conditions, and the extrapolation of the findings to natural rates of biodegradation is premature. Many factors affect biodegradation rates, including the nature and concentration of the specific hydrocarbon compound, the species of bacteria present and their quantity, and environmental factors such as nutrient availability, temperature, and oxygen concentrations. Initial concerns should be first, the determination of the importance of biodegradation relative to other loss factors such as volatilization and sediment sorption, and second, the determination of the ultimate fate of recalcitrant compounds and their metabolites. Author (GRA)

**N82-26879#** Brigham Young Univ., Provo, Utah. Combustion Lab.

**BASIC COMBUSTION AND POLLUTANT FORMATION PROCESSES FOR PULVERIZED FUELS Quarterly Technical Progress Report, 1 Jul. - 30 Sep. 1981**

G. J. GERMANE and L. D. SMOOT 15 Oct. 1981 44 p refs

(Contract DE-FG22-80PC-30306)

(DE82-002238; DOE/PC-30306/T4; QTPR-4) Avail: NTIS HC A03/MF A01

Basic combustion and pollutant formation processes for pulverized solid fossil fuels include coal-water mixtures and chars derived from coal pyrolysis, liquefaction or gasification processes. The factors that affect the physical properties of coal-water mixtures (CWM) were identified and characterization tests initiated to determine how these variables (e.g., solids loading, particle size, particle size distribution, additives) affect the coal slurries. A bench scale apparatus consisting of a pressure vessel and an atomizing nozzle was designed and is being fabricated. This apparatus assists in the development of handling and atomization techniques for the combustion tests. It also aids in comparing viscosities of slurries of different solids loadings and coal types. Chars were obtained for characterization tests. A series of potential tests to characterize the chars was identified. Grading and sizing of the chars was begun as well as elemental analysis. DOE

**N82-26880#** Texas Univ., Austin. Center for Energy Studies.

**ACID RAIN IN TEXAS' ENERGY FUTURE**

R. R. ARENA Aug. 1981 53 p refs

(DE82-900465; UT/CES-ES-7) Avail: NTIS HC A04/MF A01

Texas lignite as a substitute fuel for petroleum and natural gas, currently the mainstays of the Texas electric power-generating industry is considered. Acid rain may result from the use of Texas lignite for power generation under existing federal and state air pollution standards. DOE

**N82-26881#** California Univ., Los Angeles.

**ENVIRONMENTAL EFFECTS OF SOLAR-THERMAL POWER SYSTEMS. ENVIRONMENTAL EFFECTS OF HEAT TRANSFER AND STORAGE FLUIDS: PLANT TOXICITY AND MOVEMENT IN SOILS**

H. NISHITA and R. M. HAUG Jul. 1981 47 p refs

(Contract DE-AC03-76SF-00012)

(DE82-002603; UCLA-12-1301) Avail: NTIS HC A03/MF A01

Field experiments on the movement of several heat transfer and storage oils (Therminol 66, Caloria HT43, and Dow 200) in soil and on the plant toxicity of these materials were conducted. These studies were conducted in an area where the soil is nonsaline and calcareous, and the vegetation is mostly *Larrea tridentata* with *Oryzopsis hymenoides*, *Ambrosia dumosa*, and *Lycium*

*andersonii*. The abiotic factors (air and soil temperatures, rainfall, and soil moisture tension) were monitored during the experimental period and are discussed. The movement of the oils in the soil was determined in two ways - soil columns in plastic boxes and bare-soil plots. In plastic boxes, Therminol 66 moved downward about 6.3 cm in 281 days. Dow 200 moved about 3.8 cm in 281 days and showed virtually no further downward movement to the end of experimental period (555 days). In the bare-soil plots, the limit of downward movement of the oils during the experimental period was 20.6 cm, 18.7, and 14.9 cm for Therminol 66, Caloria HT43, and Dow 200, respectively. DOE

**N82-26882#** California Univ., Los Angeles. Lab. of Biomedical and Environmental Sciences.

**ENVIRONMENTAL EFFECTS OF SOLAR-THERMAL POWER SYSTEMS. THE POTENTIAL PRODUCTION OF AIR POLLUTANTS NEAR STPS RECEIVER STATIONS**

R. L. PERRINE, L. M. LIBBY, and M. SIMPSON Sep. 1981 57 p refs

(Contract DE-AG03-76SF-00012)

(DE82-002413; UCLA-12-1313) Avail: NTIS HC A04/MF A01

Data and analysis addressing the potential production of air pollutants in the high temperature, high solar intensity beam environment adjacent to a solar-thermal power system (STPS) receiver are presented. Results, (chemical equilibria, chemical kinetics, mass emission rates transport and dispersion), indicate that some air pollutants may be produced as a result of operation of large scale central receiver STPS in quantities sufficient to be of regulatory concern. These will require steps toward management. Primary concern focuses on nitric oxide, and its downstream potential pollutant products. In all likelihood the quantities produced will be small, and fully merit for solar its general recognition as an environmentally benign energy technology. Furthermore, for many solar configurations and modes of operation even this limited concern may not apply. Worst case conditions, however, are capable of leading to significant impacts from large scale high temperature STPS facilities. DOE

**N82-26889#** Exxon Research and Engineering Co., Linden, N.J. Products Research Div.

**SULFATE CONTROL TECHNOLOGY VEHICLE TESTING Final Report**

D. F. HESS, M. H. KEIRNS, and K. C. BACHMAN Dec. 1981 88 p refs

(Contract EPA-68-03-2342)

(PB82-154345; EPA-460/3-81-035) Avail: NTIS HC A05/MF A01 CSCL 13B

A total of four vehicles, two low excess air-oxidation catalyst systems and two three-way catalyst systems, were built to demonstrate the feasibility of low sulfate production automotive emission control technology. The general conclusions are summarized: (1) to successfully implement the low excess air concept the engine's fuel metering system must be capable of controlling the A/F ratio at the required 'slightly lean' value regardless of vehicle driving mode; (2) the oxidation catalyst bed must light-off quickly from cold start conditions; (3) the three-way catalyst must be maintained within its operating window by precise control of the engine at a stoichiometric A/F ratio. GRA

**N82-26966#** Air Force Aero Propulsion Lab., Wright-Patterson AFB, Ohio.

**TOXICOLOGY OF HIGH ENERGY FUELS**

M. G. MACNAUGHTON Dec. 1981 16 p refs

(Contract AF PROJ. 6302)

(AD-A116886; AFAMRL-TR-81-136) Avail: NTIS HC A02/MF A01 CSCL 06B

The development of new weapons systems, high energy fuels, and aerospace materials presents a challenge to the health professional. To avoid health hazards to Air Force personnel these hazards must be identified early in the research phase of development before acquisition decisions are made. This is only possible if the health professional works closely with the design engineers and scientists. The Air Force program to develop high

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energy cruise missile fuels is a good example of close cooperation between scientists developing these fuels and toxicologists and environmental engineers responsible for research to assess the health and environmental consequences of their deployment throughout the Air Force. A status report is given on the extensive toxicology data base research effort on these fuels. Included are data on acute, chronic and oncogenic exposures; mutagenic screening tests and emergency exposure limits. Author (GRA)

**N82-27194#** Draper (Charles Stark) Lab., Inc., Cambridge, Mass.

### **UTILIZATION OF FLYWHEEL-HYBRID DRIVE TRAINS FOR COMMERCIAL TAXICAB VEHICLES**

D. EISENHAURE, J. DOWNER, T. BLIAMPTIS, and B. JOHNSON  
Jul. 1981 79 p refs

(Contract W-7405-ENG-48)

(DE82-001670; UCRL-15395) Avail: NTIS HC A05/MF A01

The economic criteria, technical requirements, and conservation potential of flywheel hybrid drive train, utilized in taxicabs operated in commercial fleets are quantified. The development requirements for this application are identified in light of these factors. Use of hybrid drive trains in urban taxicabs was shown to make substantial fuel efficiency gains possible. For the vehicle used in this study, the projected gains are from an existing 10.5 mpg to a maximum of 32 mpg. DOE

**N82-27195#** California Univ., Livermore. Lawrence Livermore Lab.

### **STUDY OF ACCUMULATOR PASSENGER CARS BASED ON THE IFIELD HYDROSTATIC PUMP/MOTOR UNIT**

N. H. BEACHLEY and D. R. OTIS 24 Aug. 1981 140 p refs

(Contract W-7405-ENG-48)

(DE82-002522; UCRL-15390) Avail: NTIS HC A07/MF A01

A hydrostatic variable displacement pump/motor unit, called the Ifield accumulator, has significantly higher efficiencies than any other known units, and has the potential to make high mileage accumulator vehicles a practical reality. A preliminary study to determine the potential fuel economy improvement of an Ifield accumulator vehicle, and whether or not additional research and development work in this area is justified is presented. Efficiency data in equation form was provided by Ifield. The calculated results are quite promising, indicating mileage on the order of 60 mpg for a 3000 lb vehicle over the federal urban driving cycle (FUDC), and mileage on the order of 85 mpg for the New York City cycle. These figures appear to be feasible not only on a system with two pump/motor units, but on one with a single pump/motor unit. Fuel economy figures compare favorably with those of a comparable flywheel energy storage vehicle. The above figures are based on the use of accumulators with plastic foam as a heat sink to provide nearly isothermal operation with correspondingly low thermodynamic losses. With a conventional accumulator, the fuel mileage calculated for the FUDC drops approximately 9%. The required accumulator weight is calculated to be about 100 lb, using state of the art composite construction. Foam, if used, would add approximately 30% to the weight. DOE

**N82-27280\*#** Operations Research, Inc., Silver Spring, Md.  
**BENEFIT COST ANALYSIS OF THE AIRCRAFT ENERGY EFFICIENCY PROGRAM Final Report**

J. BAUCHSPIES, F. HOPKINS, and L. KAPLAN Nov. 1980 242 p refs Revised

(Contract NASW-2961)

(NASA-CR-169116; NAS 1.26:169116) Avail: NTIS HC A11/MF A01 CSCL 01C

Analyses were reviewed in light of rapid and dramatic changes in fuel cost and availability, as well as significant changes in the economic and political climate relating to these factors. N.W.

**N82-27452#** Sassi Corp., Indianapolis, Ind.

### **PROCESS SELECTION AND INVESTMENT ANALYSIS, METHANATION FACILITY FOR PUROX PYROLYSIS SYSTEM OFF-GAS**

Sep. 1981 173 p

(Contract DE-AC01-79CS-20449)

(DE82-004584; DOE/CS-20449/1) Avail: NTIS HC A08/MF A01

The Sassi Corporation of Indianapolis, Indiana, is investigating the commercial viability of converting refuse (trash and garbage) to synthetic natural gas. This conversion is accomplished by: (1) shredding and preparing the refuse for conversion; (2) producing a gas of low calorific value from the refuse using the Union Carbide Purox Process; and (3) methanating the Purox off-gas to a quality suitable for sale in the existing gas distribution system. Based on the scheme envisioned, a process design has been prepared for a facility which processes 46.87 MMSCFD of Purox off-gas, resulting in 26.4 MMSCFD of SNG. A detailed process description, process flow diagram, and a detailed description of the mechanical aspects of the plant are included in this report. Investment analysis reveals that capital requirements for the facility are approximately \$47,320,000, resulting in a payout, not including taxes or interest, of 8.3 years. DOE

**N82-27743\*#** Curtiss-Wright Corp., Wood-Ridge, N.J. Rotary Engine Facility.

### **ADVANCED STRATIFIED CHARGE ROTARY AIRCRAFT ENGINE DESIGN STUDY**

P. BADGLEY, M. BERKOWITZ, C. JONES, D. MYERS, E. NORWOOD, W. B. PRATT, D. R. ELLIS (Cessna Aircraft Corp.), G. HUGGINS (Cessna Aircraft Corp.), A. MUELLER (Cessna Aircraft Corp.), and J. H. HEMBREY (Cessna Aircraft Corp.) 29 Jan. 1982 149 p refs

(Contract NAS3-21285)

(NASA-CR-165398; NAS 1.26:165398; CW-WR-81.021) Avail: NTIS HC A07/MF A01 CSCL 21A

A technology base of new developments which offered potential benefits to a general aviation engine was compiled and ranked. Using design approaches selected from the ranked list, conceptual design studies were performed of an advanced and a highly advanced engine sized to provide 186/250 shaft Kw/HP under cruise conditions at 7620/25,000 m/ft altitude. These are turbocharged, direct-injected stratified charge engines intended for commercial introduction in the early 1990's. The engine descriptive data includes tables, curves, and drawings depicting configuration, performance, weights and sizes, heat rejection, ignition and fuel injection system descriptions, maintenance requirements, and scaling data for varying power. An engine-airframe integration study of the resulting engines in advanced airframes was performed on a comparative basis with current production type engines. The results show airplane performance, costs, noise & installation factors. The rotary-engined airplanes display substantial improvements over the baseline, including 30 to 35% lower fuel usage. A.R.H.

**N82-27802#** Tennessee Valley Authority, Chattanooga. Office of Natural Resources.

### **REMOTE SENSING OF SULFUR DIOXIDE EFFECTS ON VEGETATION. VOLUME 1: SUMMARY Final Report**

C. D. SAPP Jul. 1981 31 p 2 Vol.

(Contract EPA-IAG-D8-E721)

(DE82-900580; TVA/ONR/ARP-81/5-VOL-1; EPA-660/7-81-113) Avail: NTIS HC A03/MF A01

Three techniques for detecting and mapping sulfur dioxide (SO<sub>2</sub>) effects on the foliage of sensitive crops and trees near large, coal-fired power plants were tested and evaluated: spectroradiometry, photometric analysis of aerial photographs, and computer analysis of airborne multispectral scanner data. DOE

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**N82-27803#** Tennessee Valley Authority, Chattanooga. Office of Natural Resources.

### REMOTE SENSING OF SULFUR DIOXIDE EFFECTS ON VEGETATION. VOLUME 2: DATA Final Report

C. D. SAPP Jul. 1981 280 p refs 2 Vol.

(Contract EPA-IAG-D8-E721)

(DE82-900581; TVA/ONR/ARP-81/6-VOL-2; EPA-600/7-81-114)

Avail: NTIS HC A13/MF A01

Airborne multispectral scanner data covering affected soybean fields were analyzed using three computer-assisted procedures: unsupervised, supervised, and pseudosupervised. The last method provided the best results. LANDSAT imagery was also investigated, but the foliar effects of SO<sub>2</sub> were too subtle to detect from orbit.

DOE

**N82-27843#** United Technologies Research Center, East Hartford, Conn.

### TECHNICAL AND ECONOMIC ASSESSMENT OF FLUIDIZED-BED-AUGMENTED COMPRESSED-AIR ENERGY-STORAGE SYSTEM: SYSTEM LOAD FOLLOWING CAPABILITY

R. D. LESSARD, W. A. BLECHER, and D. MERRICK (Coal Processing Consultants Limited) Sep. 1981 225 p refs Prepared for Pacific Northwest Lab.

(Contract DE-AC06-76RL-01830)

(DE82-000958; PNL-3895) Avail: NTIS HC A10/MF A01

The load-following capability of fluidized bed combustion-augmented compressed air energy storage systems was evaluated. A detailed technical report describing the part-load and load following capability of both the pressurized fluid bed combustor and the entire pressurized fluid bed combustor/-compressed air energy storage systems is presented. The conclusions are encouraging and indicate that the open-bed PFBC/CAES power plant should provide good part-load and transient performance, and should have no major equipment-related constraints, specifically, no major problems associated with the performance or design of either the open-end PFBC or the PFBC/CAES power plant in steady-state, part-load operation are envisioned. The open-bed PFBC/CAES power plant would have a load following capability which would be responsive to electric utility requirements for a peak-load power plant.

DOE

**N82-27844#** United Technologies Research Center, East Hartford, Conn.

### TECHNICAL AND ECONOMIC ASSESSMENT OF FLUIDIZED-BED-AUGMENTED COMPRESSED AIR ENERGY-STORAGE SYSTEM. VOLUME 2: INTRODUCTION AND TECHNOLOGY ASSESSMENT

A. J. GIRAMONTI, R. D. LESSARD, D. MERRICK (Coal Processing Consultants Limited), and M. J. HOBSON (Acres American Inc.) Sep. 1981 230 p refs Prepared for Pacific Northwest Lab.

(Contract DE-AC06-77RL-01830)

(DE82-000938; PNL-3686-VOL-2) Avail: NTIS HC A11/MF A01

The results are described of a study subcontracted by PNL to the United Technologies Research Center on the engineering feasibility and economics of a CAES concept which uses a coal fired, fluidized bed combustor (FBC) to heat the air being returned from storage during the power production cycle. By burning coal instead of fuel oil, the CAES/FBC concept can completely eliminate the dependence of compressed air energy storage on petroleum fuels. A discussion of program background and an in-depth coverage of both fluid bed combustion and turbomachinery technology pertinent to their application in a CAES power plant system is presented. The CAES/FBC concept appears technically feasible and economically competitive with conventional CAES. However, significant advancement is required in FBC technology before serious commercial commitment to CAES/FBC can be realized.

DOE

**N82-27849#** Delegationen foer Energiforskning, Stockholm (Sweden).

### LONG-TERM ENERGY OPTIONS FOR SWEDEN. THE IEA MODEL AND SOME SIMULATION RESULTS

P. A. BERGENDAHL and C. BERGSTROEM 1981 261 p refs

(DE82-900916; DFE-36) Avail: NTIS (US Sales Only) HC

A12/MF A01; DOE Depository Libraries

Major findings of the simulations made using the Swedish version of the MARKAL model are summarized. It is an attempt to determine what new energy supply, conversion and end-use technologies will be needed in Sweden during the next several decades, and to assess the energy contribution that can be expected from them. The reader is acquainted with the analytical approach to the planning and analysis of energy research and development programs used. An overview is given of the problem structure and analytical apparatus.

DOE

**N82-27851#** Air Products and Chemicals, Inc., Allentown, Pa. DEMONSTRATION OF A NITROGEN-BASED CARBURIZING ATMOSPHERE Final Report

R. J. PEARTREE Sep. 1981 140 p refs

(Contract DE-AC07-78CS-40234)

(DE82-004196; DOE/CS-40234/T2) Avail: NTIS HC A07/MF

A01

A comprehensive energy study comparing nitrogen-based atmospheres to endothermic atmospheres was completed. Energy savings of up to 18.8% combined with production increases averaging 10% are possible with nitrogen-methanol carburizing atmospheres. Although the economics will vary depending on application and location, these energy savings and production increases are available to the heat treater at costs comparable to traditional endothermic atmosphere. The nitrogen-methanol atmosphere systems are controllable using all of the currently available methods of carbon control.

DOE

**N82-27856#** Fraunhofer-Inst. fuer Systemtechnik und Innovationsforschung, Karlsruhe (West Germany).

### POSSIBILITIES FOR ENERGY CONSUMPTION THROUGH MICROELECTRONICS Final Report

G. ANGERER, E. BOEHM, U. HAUSER, E. JOCHEN, W. MANNSBART, T. MENTZEL, R. DIEHL (Fraunhofer-Inst. fuer Angewandte Festkoerperphysik), M. KONSTANZER (Fraunhofer-Inst. fuer Angewandte Festkoerperphysik), A. GOETZBERGER (Fraunhofer-Inst. fuer Bauphysik), D. OSWALD (Fraunhofer-Inst. fuer Bauphysik) et al. Bonn Bundesministerium fuer Forschung und Technologie Feb. 1982 540 p refs In GERMAN; ENGLISH summary Sponsored by Bundesministerium fuer Forschung und Technologie

(BMFT-FB-T-82-0022; ISSN-0340-7608) Avail: NTIS HC

A23/MF A01; Fachinformationszentrum, Karlsruhe, West

Germany DM 70,50

Application of microelectronic sensors, integrated circuits, and actuators in order to control energy consuming processes and reduce energy losses was studied. The energy saving potential of microelectronics was investigated in various sectors of secondary energy consumption, i.e., heating, electrical household equipment, road traffic, business, hot water and steam generation, and use of electrical motors. Findings are based on secondary energy consumption in the Federal Republic of Germany. Results show that potential energy savings can reduce demand for primary energy by 265 to 290 billion kilowatt hours. (8% to 9% of the total demand of the Federal Republic of Germany).

Author (ESA)

**N82-27870#** General Accounting Office, Washington, D. C. Energy and Minerals Div.

### THE DEBATE OVER ACID PRECIPITATION: OPPOSING VIEWS, STATUS OF RESEARCH

11 Sep. 1981 54 p refs

(AD-A106925; GAO/EMD-81-131) Avail: NTIS HC A04/MF A01 CSCL 04B

The use of coal as a substitute for imported oil is raising concern over the possible impact of acid precipitation on the

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environment and human health. Precipitation can become acidified when sulfur and nitrogen oxides emitted by fossil-fueled powerplants, vehicles, and other man-made or natural sources are chemically changed in the atmosphere and return to Earth as acid compounds. Environmental organizations and some agencies and interest groups contend that more stringent emission controls are needed immediately. On the other hand, some agencies and many industries, particularly in the coal and utility sectors, argue that much more research is needed to determine if achievable emissions reductions could significantly diminish the extent of acid precipitation, and if the benefits of such regulations would be worth their potentially high cost. GRA

**N82-27874#** California Univ., Livermore. Lawrence Livermore Lab.

### THREE-DIMENSIONAL, CONSERVATION EQUATION MODEL FOR SIMULATING LNG VAPOR DISPERSION IN THE ATMOSPHERE

S. T. CHAN, P. M. GRESHO, and D. L. ERMAK Sep. 1981 18 p refs

(Contract W-7405-ENG-48)

(DE82-001053; UCID-19210) Avail: NTIS HC A02/MF A01

A numerical model for simulating the vapor spread and dispersion associated with LNG releases in the atmosphere is described. The model is based on solving the set of three dimensional, time dependent, conservation equations governing incompressible flows. Spatial discretization is performed via a modified Galerkin finite element method (GFEM), and time integration is carried out via the forward Euler method (pressure is computed implicitly, however). Cost effective techniques including subcycling, mass lumping, and reduced Gauss-Legendre quadrature are discussed. Numerical results obtained by using this model are presented. DOE

**N82-28150#** Johnson (E. R.) Associates, Inc., Reston, Va.

### PRELIMINARY ASSESSMENT OF ALTERNATIVE DRY STORAGE METHODS FOR THE STORAGE OF COMMERCIAL SPENT NUCLEAR FUEL

Nov. 1981 230 p refs

(Contract DE-AC09-80ET-47929)

(DE82-002303; DOE/ET-47929/1) Avail: NTIS HC A11/MF A01

The results are presented for an assessment of the (1) state of technology, (2) licensability, (3) implementation schedule, and (4) costs of alternative dry methods for storage of spent fuel at a reactor location when used to supplement reactor pool storage facilities. The methods of storage that was considered included storage in casks, drywells, concrete silos and air-cooled vaults. The impact of disassembly of spent fuel and storage of consolidated fuel rods was also determined. The economic assessments were made based on the current projected storage requirements of Virginia Electric and Power Company's Surry Station for the period 1985 to 2009, which has two operating pressurized water reactors (824 MWe each). It was estimated that the unit cost for storage of spent fuel in casks would amount to \$117/kgU and that such costs for storage in drywells would amount to \$137/kgU. However, based on the overall assessment it was concluded both storage methods were equal in merit. Modular methods of storage were generally found to be more economic than those requiring all or most of the facilities to be constructed prior to commencement of storage operations. DOE

**N82-28221#** Jorgenson (Dale W.) Associates, Cambridge, Mass.

### ENERGY-ECONOMY ANALYSIS AND APPLICATION TO R AND D PLANNING Final Report, Oct. 1980 - Sep. 1981

E. A. HUDSON and P. A. DOROSH Oct. 1981 98 p

(Contract GRI-5080-310-0329)

(PB82-141128; GRI-81/0004) Avail: NTIS HC A05/MF A01 CSCL 05C

Projections of energy and economic conditions and analysis of energy economy interactions are based on a simulation model of the structure and growth of the U.S. economy (the Hudson-Jorgenson model). A reference projection is first

constructed; this provides a reasonable estimate of future energy and economic conditions as well as providing information on economic growth, inflation and other variables required in project appraisal and R and D planning. Next, detailed analyses of energy economy interactions are performed; these examine the mechanisms through which energy changes affect economic structure and growth, and also provide a basis for quantitatively estimating the economic effects of specific energy changes. GRA

## 02

## SOLAR ENERGY

Includes solar collectors, solar cells, solar heating and cooling systems, and solar generators.

**A82-28881**

### PURIFICATION OF RICE HULLS AS A SOURCE OF SOLAR GRADE SILICON FOR SOLAR CELLS

J. A. AMICK (Exxon Research and Engineering Co., Linden, NJ) (Electrochemical Society, Meeting, Hollywood, FL, Oct. 5-10, 1980.) Electrochemical Society, Journal, vol. 129, Apr. 1982, p. 864-866. refs

**A82-29233**

### VARIATION OF MINORITY CARRIER LIFETIME WITH LEVEL OF INJECTION IN P-N-JUNCTION DEVICES

S. K. AGARWAL, S. C. JAIN, and S. HARSH (Solid State Physics Laboratory, Delhi, India) Electronics Letters, vol. 18, Apr. 1, 1982, p. 298, 299. refs

Minority-carrier lifetime as a function of level of injection has been measured for a number of Si and Ge p-n-junction diodes using reverse recovery and forward current-induced voltage decay methods. It is found that the lifetime always increases with injection level if the effect of the finite thickness of the base of the diode is taken into account while interpreting the experimental results. The decrease in the lifetime values reported in the literature appears to be due to erroneous interpretation of the experimental data. (Author)

**A82-29248**

### ELECTRODEPOSITION OF SOLAR SILICON

D. ELWELL and R. S. FEIGELSON (Stanford University, Stanford, CA) Solar Energy Materials, vol. 6, Jan.-Feb. 1982, p. 123-145. Research supported by the U.S. Department of Energy. refs

A review is presented of experimental data on the electrodeposition of silicon from molten salt and organic solutions, with emphasis on studies reported in the last three years. The potential of this method for photovoltaic applications is considered. Electrodeposition of silicon at temperatures above its melting point is a promising method of producing inexpensive silicon to be recrystallized by pulling or casting crystals. Deposition of layers onto graphite by electrowinning or electrorefining requires a relatively slow deposition rate but has the advantage of eliminating several processing steps. (Author)

**A82-29249**

### TEMPERATURE DEPENDENCE OF SILICON SOLAR CELL CHARACTERISTICS

N. D. ARORA and J. R. HAUSER (North Carolina State University, Raleigh, NC) Solar Energy Materials, vol. 6, Jan.-Feb. 1982, p. 151-158. Research supported by the Solar Energy Research Institute. refs

The effects of temperature on the characteristics of p-n junction solar cells are investigated theoretically. An exact numerical model of the semiconductor transport equations is used to calculate the output parameters of the cell taking into account temperature effect on the material parameters of the cell. These calculations show that the temperature coefficient of solar cell parameters such as

open-circuit voltage, short-circuit current, efficiency, etc., are typically nonlinear over the range of temperature (300-450 K) studied in agreement with the experimental results as against a constant value obtained by simple calculations. (Author)

**A82-29250****SOLAR ABSORPTANCE AND THERMAL EMITTANCE OF AL<sub>2</sub>O<sub>3</sub> FILMS ON AL - A THEORETICAL ASSESSMENT**

T. S. ERIKSSON, A. HJORTSBERG, and C. G. GRANQVIST (Chalmers Tekniska Hogskola, Goteborg, Sweden) *Solar Energy Materials*, vol. 6, Jan.-Feb. 1982, p. 191-199. refs

Solar absorptance and thermal emittance for Al<sub>2</sub>O<sub>3</sub> films on Al are computed by use of a previous determination of the dielectric function for evaporated Al<sub>2</sub>O<sub>3</sub>. The solar absorptance is about 0.13 for films thicker than 0.4 micron. Low thermal emittance suitable for solar thermal conversion, requires film thicknesses lower than 0.8 micron, whereas rather high emittance can be obtained for films thicker than 3 microns. Theoretical results are consistent with published experimental data. (Author)

**A82-29317****PHOTOCHEMICAL ENERGY CONVERSION IN CHLOROPHYLL-CONTAINING LIPID BILAYER VESICLES**

J. K. HURLEY and G. TOLLIN (Arizona, University, Tucson, AZ) *Solar Energy*, vol. 28, no. 3, 1982, p. 187-196. Research supported by the U.S. Department of Energy. refs

Lipid bilayer vesicles containing incorporated chlorophyll molecules are being extensively studied as potential biomimetic solar energy conversion systems based upon green plant photosynthesis. Considerable information is now available concerning the structure and excited state dynamics of these systems. Electron-transfer reactions involving the chlorophyll triplet state and donor and acceptor species have been investigated by both steady-state and transient techniques, and understanding of detailed mechanisms is beginning to emerge. Under appropriate conditions, it has been possible to achieve high degrees of conversion of excited states into energy-rich products, and energy-wasting recombinations have been considerably retarded. Most recently, mechanistic studies of vectorial electron transfer across a lipid bilayer from donor to acceptor via the chlorophyll triplet state have begun, which promise to provide a new level of insight into the factors which control energy storage efficiency in these systems. (Author)

**A82-29318****ON THE CLIMATIC OPTIMIZATION OF THE TILT AND AZIMUTH OF FLAT-PLATE SOLAR COLLECTORS**

C. J. WILLMOTT (Delaware, University, Newark, DE) *Solar Energy*, vol. 28, no. 3, 1982, p. 205-216. Research supported by the University of Delaware. refs

**A82-29319****ANALYSIS OF OPEN INCLINED SURFACE SOLAR REGENERATORS FOR ABSORPTION COOLING APPLICATIONS - COMPARISON BETWEEN NUMERICAL AND ANALYTICAL MODELS**

C. P. PENG (Kellogg Research Center, Houston, TX) and J. R. HOWELL (Texas, University, Austin, TX) *Solar Energy*, vol. 28, no. 3, 1982, p. 265-268. refs

**A82-29693****CHARACTERIZATION OF ELECTRON TRAPS IN N/PLUS/INDIUM TIN OXIDE ON P-TYPE INP SOLAR CELLS**

H. LIM, G. SAGNES, G. BASTIDE, L. GOUSKOV, and A. OEMRY (Montpellier II, Universite, Montpellier, France) *Journal of Applied Physics*, vol. 53, Apr. 1982, p. 3085-3087. refs

Deep level transient spectroscopy has been used to study main traps in n(plus)ITO/plnP solar cells. Three electron traps have been found: E1 at 320 meV (capture cross section of 10 to the -13 sq cm), E2 at 520 meV (capture cross section of 10 to the -9th sq cm), and E3 at 475 meV (capture cross section of 10 to the -13th sq cm) below the conduction band. The characteristics

of levels E1 and E2 were also well observed in n-InP Schottky diode. V.L.

**A82-29694\*** Illinois Univ., Urbana.**REDUCTION OF SOLAR CELL EFFICIENCY BY BULK DEFECTS ACROSS THE BACK-SURFACE-FIELD JUNCTION**

C. T. SAH (Illinois, University, Urbana, IL), K. A. YAMAKAWA, and R. LUTWACK (California Institute of Technology, Jet Propulsion Laboratory, Pasadena, CA) *Journal of Applied Physics*, vol. 53, Apr. 1982, p. 3278-3290. Research supported by the U.S. Department of Energy.

The degradation of solar cell performance due to bulk defects distributed across the back-surface field junction is analyzed in terms of a three-region developed-perimeter model. Families of curves are computed and their physical significance is discussed in detail with reference to three parameters used to characterize the defects: defect area, defect density, and defect surface recombination velocity. A reduction in the open-circuit voltage due to the presence of a defect is expressed as a function of the defect area, density, cell thickness, and defect surface recombination velocity. Numerical examples are presented to illustrate the importance of the particular defect parameters. V.L.

**A82-29695****BACK SURFACE FIELD AND VERTICAL SOLAR CELL**

Y.-T. YANG (National Tsinghua University, Hsinchu, Republic of China) *Journal of Applied Physics*, vol. 53, Apr. 1982, p. 3333, 3334. refs

A light-spot traverse experiment has been performed on a pnn(+) vertical solar cell initially with a tungsten-halogen lamp and then with a monochromatic He-Ne laser beam as the light sources. It is found that the cell is characterized by relatively high ability of light-to-electric-power conversion near the high back-surface field region. Results indicate that there are two strong source regions of power conversion: one near the pn junction and the other near the nn(+) junction, near which the back-surface field exists. V.L.

**A82-29696****TRANSPORT IN HYDROGENATED AMORPHOUS SILICON P-I-N SOLAR CELLS**

R. S. CRANDALL (RCA Laboratories, Princeton, NJ) *Journal of Applied Physics*, vol. 53, Apr. 1982, p. 3350-3352. refs (Contract XG-0-93721)

A simple model of a p-i-n structure is used to obtain solutions to the continuity equations in terms of elementary functions. In addition, a regional approximation is used to obtain a simple expression for the photocurrent. It is found that for weakly absorbed light, the shape of photocurrent-voltage curve is completely specified by the electron and hole drift lengths. Furthermore, it is the carrier with the longer drift length that determines the current-voltage curve and hence the solar cell fill factor. V.L.

**A82-29790****OPTICAL FIBERS AND SOLAR ENERGY [LES FIBRES OPTIQUES ET L'ENERGIE SOLAIRE]**

J. DUGAS, J.-M. CARIOU, and L. MARTIN (Toulouse III, Universite, Toulouse, France) *L'Aeronautique et l'Astronautique*, no. 92, 1982, p.57-61. In French.

The possibilities for the use of optical fibers for the transmission of solar energy from the focus of a solar concentrator to a device for solar energy utilization are considered. The transmittance properties of currently available optical fibers are shown to be suitable for solar energy transmission, and a device for the coupling of focused solar energy into an optical fiber is presented which is based on the use of a mirror providing an image of the sun coinciding with the entrance end of a single light conductor. The integration of many such modules, each with a maximum output power of about 2W, may be used in applications such as solar furnaces for hydrogen production, photovoltaic energy conversion or thermal electricity generation. A.L.W.

## 02 SOLAR ENERGY

**A82-30057**

**HIGH-EFFICIENCY SILICON SOLAR CELLS AND PROSPECTS FOR THEIR IMPROVEMENT [VYSOKOEFFEKTIVNYE KREMNEVYE FOTOPREOBRAZOVATELI I PERSPEKTIVY IKH SOVERSHENSTVOVANIYA]**

N. M. BORDINA, G. M. GRIGOREVA, G. S. DALETSKII, E. V. ZHIDKOVA, and A. K. ZAITSEVA (Vsesoiuznyi Nauchno-Issledovatel'skii Institut Istochnikov Toka, Moscow, USSR) *Geliotekhnika*, no. 1, 1982, p. 3-7. In Russian. refs

The current status of the design of high-efficiency silicon solar cells is briefly reviewed, and the prospects for the improvement of the efficiency of such cells are assessed. Particular consideration is given to the advantages of cells with  $n(+)-p-p(+)$  structure, thin-base cells, and cells with  $p-i-n$  structure. B.J.

**A82-30058**

**NUMERICAL SOLUTION OF THE ONE-DIMENSIONAL BOUNDARY VALUE PROBLEM OF CHARGE TRANSFER IN SOLAR-CELL ELEMENTS [CHISLENNOE RESHENIE ODNOMERNOI KRAEVOI ZADACHI PERENOSA ZARIADA V SOLNECHNYKH ELEMENTAKH]**

N. M. BOGATOV, L. I. GROMOVOI, M. B. ZAKS, and E. V. LELIUKH *Geliotekhnika*, no. 1, 1982, p. 7-14. In Russian. refs

The paper presents an algorithm for the numerical solution of the Shockley-model equations with the additional condition of electroneutrality. As an illustration, the method is used to determine the volt-ampere characteristics of an  $n(+)-p$  silicon solar-cell element. B.J.

**A82-30059**

**THE EFFECT OF THE INTERMEDIATE LAYER ON THE CHARACTERISTICS OF SCHOTTKY-BARRIER SOLAR-CELL ELEMENTS [VLIYANIE PROMEZHUTOCHNOGO SLOIA NA KHARAKTERISTIKI SOLNECHNYKH ELEMENTOV S BAR'EROM SHOTTKI]**

O. S. ZINETS, S. S. KILCHITSKAIA, and V. I. STRIKHA (Kievskii Gosudarstvennyi Universitet, Kiev, Ukrainian SSR) *Geliotekhnika*, no. 1, 1982, p. 15-19. In Russian. refs

The diode-theory approximation is used to obtain analytic expressions for the short-circuit current and open-circuit voltage of Schottky-barrier solar-cell elements with a thin intermediate layer. Formulas are presented which take into account various conditions of charge transfer into the metal as well as recombination losses in the quasi-neutral region. A numerical analysis is presented of the dependences of short-circuit current, open-circuit voltage, and efficiency on the thickness of the intermediate layer for the case of silicon at AM0. It is found that there is an optimal thickness of the intermediate layer at which the efficiency is maximal. B.J.

**A82-30060**

**SOLAR POWER STATIONS - HEAT TRANSFER AND THERMAL OPTIMIZATION IN THE PRODUCTION OF SATURATED WATER VAPOR [SOLNECHNYE ENERGETICHESKIE STANTSII - TEPLOBMEN I TEPLOVAIA OPTIMIZATSIYA PRI GENERIROVANII NASYSHCHENNOGO VODIANOGO PARA]**

D. I. TEPLIAKOV and R. R. APARISI (Gosudarstvennyi Nauchno-Issledovatel'skii Energeticheskii Institut, Moscow, USSR) *Geliotekhnika*, no. 1, 1982, p. 23-30. In Russian. refs

**A82-30061**

**INVESTIGATION OF MIRROR CONCENTRATORS INTENDED FOR OPERATION WITH HIGH-CURRENT SOLAR CELLS [ISSLEDOVANIE ZERKAL'NYKH KONTSENTRATOROV, PREDNAZNACHENNYKH DLIA RABOTY S SIL'NOTOCHNYMI SOLNECHNYMI ELEMENTAMI]**

A. K. ALIMOV, M. U. USMANOV, G. IA. UMAROV, KH. K. ARIPOV, V. R. LARIONOV, and V. D. RUMIANTSEV (Akademiya Nauk Uzbekskoi SSR, Fiziko-Tekhnicheskii Institut, Tashkent, Uzbek SSR; Akademiya Nauk SSSR, Fiziko-Tekhnicheskii Institut, Leningrad, USSR) *Geliotekhnika*, no. 1, 1982, p. 35-37. In Russian. refs

An analysis is presented of the concentration properties of circular parabolic mirrors made of sheet glass with a diameter of

500 mm. The unit cost of these mirrors is assessed in the case of their use with high-current  $nGaAs-pGaAs-p(+)/AlGaAs$  heterojunction solar cells. Test results show these mirrors to be cost effective with respect to electrical power generation. B.J.

**A82-30062**

**A METHOD FOR CALCULATING THE RADIANT ENERGY INCIDENT ON A VAPOR GENERATOR IN A SOLAR POWER STATION [METOD RASCHETA LUCHISTOI ENERGII, PADAIUSHCHEI NA POVERKHNOSTI PAROGENERATORA SES]**

S. BATMUNKH *Geliotekhnika*, no. 1, 1982, p. 42-47. In Russian.

An algorithm is developed for calculating the distribution of radiant fluxes along the perimeter of a solar vapor generator (SVG), the mean value of the utilization coefficient of the mirror surface, and the total value of radiant fluxes on the SVG in the course of a day. The method is used to calculate the aforementioned parameters for a tower-type solar power station located in the Crimea for the months of June, September, and December. B.J.

**A82-30327**

**AMERICAN VACUUM SOCIETY, NATIONAL SYMPOSIUM, 28TH, ANAHEIM, CA, NOVEMBER 2-6, 1981, PROCEEDINGS. PARTS 1 & 2**

*Journal of Vacuum Science and Technology*, vol. 20, Mar.; Apr. 1982. 703 p.; 546 p.

Among the vacuum technology topics considered are thin-film photovoltaics, energy-related optical coatings, coatings and surfaces with specific properties, the deposition, characterization and diagnostics of thin films, grain boundaries and adhesion, critical aspects of semiconductor device processing, the effects of ion bombardment on surfaces, chemisorption and catalysis, electronic excitations and stimulated desorption, and surface vibrational spectroscopy. Also discussed are the dynamics of molecule-surface interactions, surface electronic structure, interface electronics and geometric structures, Schottky barrier formation and silicide interfaces, the growth and structure of interfaces, epitaxial growth, laser and electron beam processing, oxide-semiconductor interfaces, the atomic and electronic structure of semiconductor surfaces, and microlithography. O.C.

**A82-30328**

**POLYCRYSTALLINE THIN FILMS FOR TERRESTRIAL SOLAR CELLS**

A. ROTHWART (Drexel University, Philadelphia, PA) *Journal of Vacuum Science and Technology*, vol. 20, Mar. 1982, p. 282-289. refs

The development of polycrystalline thin film solar cells for terrestrial use is reviewed. The topics covered include economic aspects, efficiency, lifetime, range of materials, operation and structure of the cells, thin film effects related to surfaces, grain boundaries and interfaces, deposition and post deposition effects, stability, process sensitivity, and substrate requirements. The status of the leading thin film materials is presented. (Author)

**A82-30329**

**AMORPHOUS THIN FILMS FOR TERRESTRIAL SOLAR CELLS**

D. E. CARLSON (RCA Laboratories, Princeton, NJ) *Journal of Vacuum Science and Technology*, vol. 20, Mar. 1982, p. 290-295. Research supported by RCA refs

(Contract EY-76-C-03-1286; XJ-9-8254; XG-0-9372-1)  
Progress in amorphous semiconductor solar cell technology at RCA Laboratories and other research organizations is reviewed. The performance of cells is discussed for homojunction  $p-i-n$  structures and structures utilizing hydrogenated amorphous alloys of Si-C, Si-F, Si-Ge, and B-Si. Recently, several organizations have reported conversion efficiencies in the range of 6.0%-7.5% for homojunction  $p-i-n$  cells and structures using alloys of Si-C-H and Si-F-H. The effects of various impurities on solar-cell performance are discussed. Data on the diffusion of various contact materials and dopants in amorphous Si at elevated temperatures are also presented. (Author)

A82-30861

**SOLAR GRADE SILICON AS A POTENTIAL CANDIDATE MATERIAL FOR LOW-COST TERRESTRIAL SOLAR CELLS**

S. PIZZINI (Milano, Università; Heliosil S.p.A., Milan, Italy) Solar Energy Materials, vol. 6, Mar.-Apr. 1982, p. 253-297. refs

The present status of conventional and advanced silicon production processes is examined in order to discuss their suitability as sources of low cost silicon feedstocks for photovoltaic application. This discussion supports the view that only methods based on advanced Siemens technology and upgrading metallurgical silicon seem practical candidates for producing silicon feedstocks for solar use, albeit upgraded MG silicon needs some yet ill-defined intermediate purification step to be transformed to a solar grade material. (Author)

A82-30862

**HYDROGENATED AMORPHOUS SILICON CARBIDE AS A WINDOW MATERIAL FOR HIGH EFFICIENCY A-SI SOLAR CELLS**

Y. TAWADA, H. OKAMOTO, and Y. HAMAKAWA (Osaka University, Toyonaka, Japan) Solar Energy Materials, vol. 6, Mar.-Apr. 1982, p. 299-315. Research sponsored by the Ministry of Education and Agency of Industrial Science and Technology. refs

A82-30863

**A PHOTOELECTROCHEMICAL CELL BASED ON CHEMICALLY DEPOSITED  $\text{Sb}_2\text{Se}_3$  THIN FILM ELECTRODE AND DEPENDENCE OF DEPOSITION ON VARIOUS PARAMETERS**

R. N. BHATTACHARYA and P. PRAMANIK (Indian Institute of Technology, Kharagpur, India) Solar Energy Materials, vol. 6, Mar.-Apr. 1982, p. 317-322. Research supported by the Council of Scientific and Industrial Research. refs

The photoelectrochemical behavior of chemically deposited  $\text{Sb}_2\text{Se}_3$  thin film in aqueous solution is studied. The short-circuit photocurrent is about 0.45 mA/sq cm and open-circuit photovoltage is about 0.37 V. This paper also describes the dependence of the deposition on pH, temperature and deposition mixture. (Author)

A82-30865

**FURTHER STUDIES OF THE PHOTOELECTROCHEMICAL PROPERTIES OF THE GROUP VI TRANSITION METAL DICHALCOGENIDES**G. KLINE, K. K. KAM, R. ZIEGLER (U.S. Department of Energy, Ames Laboratory, Ames, IA), and B. A. PARKINSON (Solar Energy Research Institute, Golden, CO) Solar Energy Materials, vol. 6, Mar.-Apr. 1982, p. 337-350. refs  
(Contract W-7405-ENG-82; XP-9-98198-1)

The photoelectrochemical behavior of synthetic crystals of  $\text{WS}_2$ ,  $\text{MoS}_2$  and crystals with mixed metal and chalcogen composition was studied and compared with the behavior of  $\text{MoSe}_2$  and  $\text{WSe}_2$ . The composition and stoichiometry of the crystals and the composition of the electrolyte are varied and the behavior of the materials in a regenerative liquid junction solar cell is measured and analyzed. The quantum yields as a function of wavelength and photon flux are investigated and sunlight to electricity conversion efficiencies are measured. The formation of iodine layers on the photoelectrode surface under high illumination intensity was observed and discussed with respect to the use of these materials with solar concentrators. (Author)

A82-31098

**DAILY EFFICIENCY OF SOLAR COLLECTORS**

B. BARTOLI, V. CUOMO, M. FRANCESCA, C. SERIO (Napoli, Università, Naples, Italy), G. BARONE, and P. MATTARELLI (SoGesTA, Urbino, Italy) Applied Energy, vol. 10, Mar. 1982, p. 189-202. refs

It is shown that the daily efficiency of flat-plate solar collectors working at constant flow rate can be evaluated with a simple algorithm when their structural features are known. It is also shown that long-term performances can be calculated starting from monthly values of global radiation. (Author)

A82-31099

**ENHANCEMENT OF CONCENTRATION USING SIMPLE MULTI-PLANE MIRRORS**

J. K. SHARMA, A. DANG, and H. P. GARG (Indian Institute of Technology, New Delhi, India) Applied Energy, vol. 10, Mar. 1982, p. 233-242. refs

A numerical analysis for the concentration ratio of a tracking/nontracking solar concentrator made of plane mirrors is presented. The mirrors are assumed to be specular and nonabsorbing, and the concentration ratio with different mirror angles is considered, taking into account the acceptance angle. The concentration ratio was found to be maximized with an acceptance angle of 25 deg, and increased with increasing numbers of mirrors. The concentration tends toward that of a compound parabolic reflector. Efficient operation with concentration above 20 is noted to require tracking. M.S.K.

A82-31187

**PHOTOVOLTAIC EFFECTS IN  $\text{Cu}_2\text{O}$ - $\text{Cu}$  SOLAR CELLS GROWN BY ANODIC OXIDATION**

E. FORTIN and D. MASSON (Ottawa, University, Ottawa, Canada) Solid-State Electronics, vol. 25, Apr. 1982, p. 281-283. refs

Thin  $\text{Cu}_2\text{O}$ - $\text{Cu}$  photovoltaic cells grown by anodic oxidation of  $\text{Cu}$  in an alkaline solution at  $T = 86^\circ\text{C}$  give an open-circuit voltage of up to 400 mV and a short-circuit current density of up to 0.6 mA/sq cm under AM1 illumination. The cells display charge storage properties as well; that is, a small fraction of the solar energy can be stored and given back by the cells in the dark. (Author)

A82-31207

**PARAMETRIC PHOTOVOLTAIC CELL**

G. DE MEY (Gent, Rijksuniversiteit, Ghent, Belgium) Electronics Letters, vol. 18, Apr. 15, 1982, p. 334-336.

A new way of converting light energy into electric power is presented. A capacitor is charged periodically under influence of the chopped light flux. Electric energy stored in the capacitor can be increased by the parametric effect, i.e. the reduction of the capacitance value. The energy conversion process is analysed. The possible applications and limitations of this device are indicated and discussed. (Author)

A82-31440

**SPECTRAL SELECTIVITY OF NICKEL AND CHROMIUM ROUGH SURFACES**

R. T. KIVAIISI and L. STENSLAND (Institute of Optical Research, Stockholm, Sweden) Applied Physics A - Solids and Surfaces, vol. A27, Apr. 1982, p. 233-238. Research supported by the Swedish Institute. refs

The reflectance of metal surfaces with sinusoidal roughness of different periods and depths has been investigated experimentally. The results show clearly that the surface structure can be used to modify the optical properties of metal surfaces at different wavelengths. With a proper choice of groove depth to period ratio, nickel or chromium coatings on gratings have low reflectance in the short wavelength region, but achieve high reflectance in the infrared region. A solar absorptance as high as 93% has been obtained from such a surface. The surfaces are thought to be representative for randomly rough surfaces provided proper correlation length and height variation are chosen. Further, as the absorber is made of a single metal surface, it could be highly temperature resistant. (Author)

A82-31492

**AN OPTICAL HELIOSTAT FOR SOLAR POWER STATIONS [OPTICHESKII GELIOSTAT DLIJA SES]**

L. BERRIS and E. S. AVANESOV (Akademiia Nauk Turkmenskoi SSR, Nauchno-Proizvodstvennoe Ob'edinenie Solntse, Turkmen SSR) Akademiia Nauk Turkmenskoi SSR, Izvestiia, Seria Fiziko-Tekhnicheskikh, Khimicheskikh i Geologicheskikh Nauk, no. 1, 1982, p. 40-44. In Russian.

## 02 SOLAR ENERGY

**A82-31568**

### **USE OF SOLAR FURNACES. II - THERMOPHYSICAL PROPERTIES**

D. SURESH, W. W. S. CHARTERS (Melbourne, University, Parkville, Victoria, Australia), and P. K. ROHATGI (Council of Scientific and Industrial Research, Regional Research Laboratory, Bhopal, India) *Solar Energy*, vol. 28, no. 4, 1982, p. 273-280. refs

The various ways in which solar furnaces have been used to measure the high-temperature thermophysical properties of materials are reviewed, with attention given to the advantages and disadvantages of these furnaces. Thermal expansion experiments are seen as lacking accuracy. By introducing homogeneous heating methods, as well as precision dilatometers, this defect could be overcome. Solar furnaces must be designed so as to give larger focal areas of uniform flux density. Modifying the pulsed method so as to eliminate the requirement for homogeneity of the energy flux is thought desirable. It would also be worthwhile to design a suitable loading device to obviate complications arising out of elongation of the specimen during tests. C.R.

**A82-31571**

### **POSSIBLE APPLICATIONS OF LARGE SOLAR ARRAYS IN ASTRONOMY AND ASTROPHYSICS**

S. DANAHER, D. J. FEGAN, N. A. PORTER (University College, Dublin, Ireland), T. C. WEEKES (Mount Hopkins Observatory, Amado, AZ), and T. COLE (Ford Motor Co., Dearborn, MI) *Solar Energy*, vol. 28, no. 4, 1982, p. 335-343. Research supported by the National Board of Science and Technology of Ireland. refs

It is pointed out that the large collection area of solar test facilities may be useful in certain astronomical experiments. Since only nighttime hours would be involved, there would be no conflict with daytime solar research. Although solar concentrators are optically crude by conventional astronomical telescope standards, there are certain applications where angular resolutions of 0.25 deg can be tolerated. These applications are discussed, along with results from the nighttime use of large concentrators. A table comparing the parameters of a typical astronomical telescope with those of a typical solar concentrator is included. Four areas of astronomical research where solar concentrators might be useful are discussed. They are the detection of Cerenkov light from extensive air showers, optical bursts, optical detection of meteors, and stellar photometry. C.R.

**A82-31856#**

### **SATELLITE THERMAL DESIGN AND ANALYSES FOR TITAN 34D/IUS AND STS/IUS LAUNCH VEHICLE ENVIRONMENTS**

H. FACTOR and E. A. STIPANDIC (General Electric Co., Space Div., Valley Forge, PA) *American Institute of Aeronautics and Astronautics and American Society of Mechanical Engineers, Joint Thermophysics, Fluids, Plasma and Heat Transfer Conference*, 3rd, St. Louis, MO, June 7-11, 1982, AIAA 8 p. (AIAA PAPER 82-0828)

T34D/IUS launch vehicle studies are considered, taking into account heater power studies for a cold mission and solar array studies. A description of STS/IUS studies is also provided. Solar array high temperature problems were identified by examining in detail the worst case attitudes/timelines for each mission phase. Parametric study results produced limiting vehicle attitudes and timelines. This data was then used to establish launch window constraints. It was found that the spacecraft heater power circuitry design was not adequate for an STS launch because both peak and average heater power requirements were exceeded. A separate heater electrical bus and a method of switching to different circuits was incorporated. For the Titan launch, a tighter launch pad environmental control was found to be necessary to limit prelaunch heater power usage and to satisfy the spacecraft battery state-of-charge requirements. G.R.

**A82-31879\*#** North Carolina State Univ., Raleigh.

### **CONVERSION OF BLACKBODY RADIATION INTO LASER ENERGY**

R. M. MCINVILLE and H. A. HASSAN (North Carolina State University, Raleigh, NC) *American Institute of Aeronautics and Astronautics and American Society of Mechanical Engineers, Joint Thermophysics, Fluids, Plasma and Heat Transfer Conference*, 3rd, St. Louis, MO, June 7-11, 1982, AIAA 6 p. refs (Contract NCC1-54) (AIAA PAPER 82-0871)

By employing detailed kinetic models, three concepts which utilize a blackbody cavity for the conversion of solar energy into laser energy using a CO<sub>2</sub> laser are analyzed and compared. In the first, the blackbody radiation is used to excite flowing CO<sub>2</sub> directly. The second and third employ a mixing laser concept with CO and N<sub>2</sub> being the donor gases. The CO is optically pumped while thermal heating excites the N<sub>2</sub>. Blackbody temperatures ranging from 1500 deg K - 2500 deg K are considered. Based on calculated laser power output per unit flow rate of CO<sub>2</sub>, it appears that the N<sub>2</sub>-CO<sub>2</sub> mixing laser is the most attractive system. (Author)

**A82-31984\*#** National Aeronautics and Space Administration. Langley Research Center, Hampton, Va.

### **SOLAR-POWERED AIRPLANE DESIGN FOR LONG-ENDURANCE, HIGH-ALTITUDE FLIGHT**

J. W. YOUNGBLOOD and T. A. TALAY (NASA, Langley Research Center, Space Systems Div., Hampton, VA) *American Institute of Aeronautics and Astronautics, International Very Large Vehicles Conference*, 2nd, Washington, DC, May 17, 18, 1982, 10 p. refs

(AIAA PAPER 82-0811)

This paper describes the performance analysis and design of a solar-powered airplane for long-endurance, unmanned, high-altitude cruise flight utilizing electric propulsion and solar energy collection/storage devices. For a fixed calendar date and geocentric latitude, the daily energy balance, airplane sizing, and airplane aerodynamics relations combine to determine airplane size and geometry to meet mission requirements. Vehicle component weight loadings, aerodynamic parameters, and current and projected values of power train component characteristics form the basis of the solution. For a specified mission, a candidate airplane design is presented to demonstrate the feasibility of solar-powered long endurance flight. Parametric data are presented to illustrate the airplane's mission flexibility. (Author)

**A82-32183**

### **DETERMINATION OF THE GRAIN BOUNDARY RECOMBINATION VELOCITY IN POLYCRYSTALLINE SILICON AS A FUNCTION OF ILLUMINATION FROM PHOTOCONDUCTANCE MEASUREMENTS**

P. PANAYOTATOS, E. S. YANG, and W. HWANG (Columbia University, New York, NY) *Solid-State Electronics*, vol. 25, May 1982, p. 417-422. refs (Contract XW-1-1272-1; DAAG29-79-C-0079)

**A82-32543**

### **THICK OPTICAL FILMS FOR THE CONDUCTION OF OPTICAL AND INFRARED RADIATION**

C. N. BAIN, B. A. GORDON, T. M. KNASEL, and R. L. MALINOWSKI (Science Applications, Inc., McLean, VA) In: *Los Alamos Conference on Optics '81*, 2nd, Los Alamos, NM, April 7-10, 1981, Proceedings. Bellingham, WA, SPIE - The International Society for Optical Engineering, 1981, p. 25-32. refs

Experimental results are presented for the characteristics of thick optical films, which can be used to direct and conduct optical and IR radiation, for the case of light concentration onto solar cells. Incident light is trapped within a thin, flat sheet of transparent material by a diffuse selective surface on the back of the transparent layer, and so directed that total internal reflection occurs, with some of the captured light finding its way back to the photovoltaic cells attached to the back of the layer. A Monte Carlo computer model is used to analyze this system, whose

achievable gain depends on layer thickness, trapping material refraction index, and solar cell shape and size. Results indicate that gains of a factor of two in power output are obtainable for the case of sparsely-packed solar cell arrays and lower factors for more densely-packed arrays. O.C.

**A82-32546****CONCENTRATION OF A CASSEGRAIN SOLAR FURNACE**

M. H. COBBLE (New Mexico State University, Las Cruces, NM) In: Los Alamos Conference on Optics '81, 2nd, Los Alamos, NM, April 7-10, 1981, Proceedings. Bellingham, WA, SPIE - The International Society for Optical Engineering, 1981, p. 46-53.

A solar furnace comprising a paraboloidal mirror for tracking the sun and a hyperboloidal reflector having one focus in common with the paraboloid is analyzed to determine the geometric concentration of the system. A numerical ray-trace analysis was carried out to study various geometrical configurations of the two reflectors. In particular, the geometric concentration is calculated for the case when the line joining the foci of the hyperboloid and the axis of revolution of the paraboloid are not coincident.

(Author)

**A82-32570#****OPTICAL CHARACTERIZATION METHOD FOR CONCENTRATING SOLAR COLLECTORS USING REVERSE ILLUMINATION**

K. MASTERSON (Solar Energy Research Institute, Golden, CO) and H. GAUL (Solar Innovations, Inc., Boulder, CO) In: Los Alamos Conference on Optics '81, 2nd, Los Alamos, NM, April 7-10, 1981, Proceedings. Bellingham, WA, SPIE - The International Society for Optical Engineering, 1981, p. 498-504. Research supported by the U.S. Department of Energy. refs

The reverse illumination optical method, by means of which solar concentrator overall alignment and aligning elements are checked, areas of extreme distortion are identified, and receiver intercept factors are determined, involves viewing the concentrator on its optical axis and through a telescope located several kilometers away. The method is simpler and less expensive than ray tracing, but does not detail the magnitude and direction of slope errors. Portions of the concentrator aperture not filled by the image of a high visibility target are ineffective in concentrating the sun's energy on a receiver of the same dimensions as the target. Image analysis of these records yields a quantitative measure of reflector alignment and intercept factor for the collector. O.C.

**A82-32693****DISTRIBUTED SERIES RESISTANCE EFFECTS IN SOLAR CELLS**

L. D. NIELSEN (Danmarks Tekniske Højskole, Lyngby, Denmark) IEEE Transactions on Electron Devices, vol. ED-29, May 1982, p. 821-827. Commission of the European Communities refs (Contract CEC-ESC-R-020-DK(G))

A mathematical treatment is presented of the effects of one-dimensional distributed series resistance in solar cells. A general perturbation theory is developed, including consistently the induced spatial variation of diode current density and leading to a first-order equivalent lumped resistance of one third the total sheet resistance. For the case of diode characteristics of exponential type and distributed resistance of arbitrary size, unified numerical results are presented for both illuminated and dark characteristics. At high forward dark currents, the distributed series resistance is shown to cause an effective doubling of the 'diode quality factor'. (Author)

**A82-32696\*** Illinois Univ., Urbana.

**EFFECT OF THICKNESS ON SILICON SOLAR CELL EFFICIENCY**

C.-T. SAH (Illinois, University, Urbana, IL), K. A. YAMAKAWA, and R. LUTWACK (California Institute of Technology, Jet Propulsion Laboratory, Pasadena, CA) IEEE Transactions on Electron Devices, vol. ED-29, May 1982, p. 903-908. Research supported by the U.S. Department of Energy and NASA. refs

A computer-aided-design study on the dependence of the efficiency peak of a back-surface field solar cell on the concentrations of the recombination and dopant impurities is presented. The illuminated current-voltage characteristics of more than 100 cell designs are obtained using the transmission line circuit model to numerically solve the Shockley equations. Using an AM 1 efficiency of 17% as a target value, it is shown that the efficiency versus thickness dependence has a broad maximum which varies by less than 1% over more than a three-to-one range of cell thicknesses from 30 to 100 microns. An optically reflecting back surface will give only a slight improvement of AM 1 efficiency, about 0.7%, in this thickness range. Attention is given to the dependence of the efficiency on patchiness across the back-surface field low-high junction in thin cells. C.R.

**A82-32891****EFFICIENCY OF HOT-CARRIER SOLAR ENERGY CONVERTERS**

R. T. ROSS (Ohio State University, Columbus, OH) and A. J. NOZIK (Solar Energy Research Institute, Golden, CO) Journal of Applied Physics, vol. 53, May 1982, p. 3813-3818. refs (Contract EG-77-C-01-4042)

A single-threshold quantum-utilizing device with hot electronic bands is reported whose solar energy conversion efficiency exceeds the efficiency of an ideal fully thermalized device. In the proposed hot-carrier flat-plate device, the excited carriers thermally equilibrate among themselves, but not with the environment. When operated under typical terrestrial conditions (AM 1.5 illumination at 300 K), the new device can convert solar energy with an efficiency of 66%, as compared with maximum efficiencies of 33% for a quantum device operating at thermal equilibrium and 52% for an ideal thermal conversion device. This is achieved due to a high Carnot efficiency resulting from a high effective absorber temperature and due to a negative potential difference between the bands leading to a reduction in reradiation from the absorber. V.L.

**A82-32892****FREQUENCY DEPENDENT CAPACITANCE STUDIES OF THE CDS/CU<sub>2</sub>S THIN-FILM SOLAR CELL**

L. V. HMURCIK (Clarkson College of Technology, Potsdam, NY) and R. A. SERWAY (James Madison University, Harrisonburg, VA) Journal of Applied Physics, vol. 53, May 1982, p. 3830-3838. refs (Contract DE-AC01-79ET-23110)

The dark capacitance of CdS cells has been measured as a function of both bias voltage and operating signal frequency. Results indicate a frequency dependence of the dark current capacitance which can be attributed to deep trapping states in the bulk CdS and at the interface; these states can be characterized by a time constant in the simple relaxation model. Photocapacitance measurements indicate that hole trapping takes place in a narrow region of the i layer near the Cu<sub>2</sub>S/CdS junction. The results are interpreted in terms of a frequency-dependent model proposed by Schibli and Milnes (1968). It is shown that the simple planar junction model commonly used to describe the CdS cell is accurate at high frequencies. V.L.

## 02 SOLAR ENERGY

A82-32893

### DEEP TRAP LEVELS IN CDS SOLAR CELLS OBSERVED BY CAPACITANCE MEASUREMENTS

L. HMURCIK (Clarkson College of Technology, Potsdam, NY), L. KETELSEN (Illinois, University, Urbana, IL), and R. A. SERWAY (James Madison University, Harrisonburg, VA) *Journal of Applied Physics*, vol. 53, May 1982, p. 3839-3847. refs (Contract DE-AC01-79ET-23110)

Capacitance measurements have been carried out as a function of reverse bias voltage and signal frequency on thin-film and single-crystal CdS solar cells. It is shown that such measurements can reveal abrupt changes in C-V plots which are attributed to the presence of deep trapping states. The anomalous change in capacitance occurs when the bias voltage raises a trapping state above the Fermi level; the strength of the anomalies depends on several factors including temperature, signal frequency, and junction properties. Measurements taken on the CdS cells indicate that at least two deep trapping states are present in the partially formed i layer of CdS, which is consistent with results reported by other workers. V.L.

A82-32894

### TEMPERATURE COEFFICIENTS OF THE OPEN-CIRCUIT VOLTAGE OF P-N JUNCTION SOLAR CELLS

C.-Y. WU and J.-F. CHEN (National Chiao Tung University, Hsinchu, Republic of China) *Journal of Applied Physics*, vol. 53, May 1982, p. 3852-3858. refs

An analytical expression is derived for the temperature coefficient of the open-circuit voltage of p-n junction solar cells with various structures. Simplified expressions for the temperature coefficient, directly applicable to conventional p-n junction and BSF solar cells, are then obtained for two special cases: (1) the saturation dark current is mainly contributed from the base and (2) the saturation dark current is mainly contributed from the emitter. It is shown that the temperature coefficient of the open-circuit voltage is largely determined by the solar cell structure, the value of the open-circuit voltage, and the effective energy-gap narrowing in the heavily doped layer. Based on the temperature coefficient, the effectiveness of a high-low junction in BSF solar cell can be evaluated; the temperature coefficient of the open-circuit voltage of a BSF cell fabricated on a thin epitaxial substrate can be also used to measure the effective energy-gap narrowing in the highly doped emitter. V.L.

A82-32895

### AN EFFECT OF BACK-SURFACE BORON IMPLANTATION ON SILICON SOLAR CELLS

M. B. SPITZER, S. J. SOLOMON, and P. R. YOUNGER (Spire Corp., Bedford, MA) *Journal of Applied Physics*, vol. 53, May 1982, p. 3926. refs

An experimental study has been carried out to investigate mechanisms responsible for the effect of open-circuit voltage enhancement in back-surface ion-implanted silicon solar cells. It is shown that open-circuit voltage enhancement in boron-implanted cells is due to a back-surface field effect, whereas gettering, if present, does not affect cell performance. This result is consistent with the observation that, for equal fluence, the damage produced by boron implantation is less than that produced by heavier ions, and, consequently, boron-implant damage is less effective as a gettering treatment for the implant and anneal conditions reported. V.L.

A82-33022

### COMPARISON OF FRESNEL LENSES AND PARABOLIC MIRRORS AS SOLAR ENERGY CONCENTRATORS

E. LORENZO and A. LUQUE (Escuela Tecnica Superior de Ingenieros de Telecomunicacion, Madrid, Spain) *Applied Optics*, vol. 21, May 15, 1982, p. 1851-1853. Research sponsored by the Ministerio de Industria. refs

A82-33255

### ENERGY CONVERSION PROCESS OF P-I-N AMORPHOUS SI SOLAR CELLS

Y. KUWANO, S. TSUDA, and M. OHNISHI (Sanyo Electric Co., Ltd., Research Center, Hirakata, Osaka, Japan) *Japanese Journal of Applied Physics*, Part 1, vol. 21, Feb. 1982, p. 235-241. Research supported by the Agency of Industrial Science and Technology. refs

The photovoltaic conversion process of a p-i-n amorphous silicon (a-Si) solar cell is investigated, and its theoretical limit efficiency is calculated. Under AM-1 illumination, the theoretical limit efficiency of the p-i-n a-Si solar cell is estimated to be 12.5%, while that under fluorescent lamp illumination is estimated to be 25.9%. In the calculation of the charge distribution in a-Si film, the Shifted U distribution is proposed for the distribution function of gap states. Poisson's equation is directly solved as a boundary condition problem, and the output characteristics of the p-i-n a-Si solar cell are calculated by solving the continuity equation for the photo-generated carriers. (Author)

A82-33546

### THE SOLAR POWER SATELLITE [SATELLITE DE PUISSANCE SOLAIRE]

P. F. COMBES (Toulouse III, Universite, Toulouse, France) *L'Aeronautique et l'Astronautique*, no. 93, 1982, p. 62-77. In French. refs (ONERA, TP NO. 1982-52)

The construction, launch, components, and operations of satellite solar power systems (SSPS) for direct beaming of solar energy converted to electricity to earth stations are outlined. The reference designs of either Si or concentrator GaAs solar cell assemblies large enough to project 5 GW of power are described. The beam will be furnished by klystrons or amplifiers for reception by rectennas on earth. Conforming to the law of amplitude and the equiphase law will permit high efficiencies, pointing accuracy, and low power deposition/sq cm, thus avoiding environmental problems, although some telecommunications systems may suffer interference. The construction of the dipole rectenna grid is sketched, noting that one receiver would be an ellipse sized at 10 x 13 km. Various forms of pollution which could result from the construction of an SSPS are examined. M.S.K.

A82-33683

### EFFICIENT CDSE/P+/N SI TUNNEL JUNCTION PHOTOANODE FOR SOLAR CELL

W. E. PINSON (Infrared Photo, Ltd., Ottawa, Canada) *Applied Physics Letters*, vol. 40, June 1, 1982, p. 970-972. refs

The 1.03-V solar photoemf generated by this CdSe/p+/n Si photoanode lends itself to solar storage applications. Evidence is presented that the 21-mA/sq cm short circuit solar photocurrent results from a low resistance tunnel path between the CdSe conduction band and the p+/n Si valence band. The dark electron current is used to calculate that the hole quasi-Fermi level at the CdSe surface of the solar illuminated open circuited photoanode lies 0.16 V below the CdSe corrosion potential. Hence, even on open circuit the CdSe surface of the illuminated photoanode will corrode. (Author)

A82-33685\* Spire Corp., Bedford, Mass.

### NON-MASS-ANALYZED ION IMPLANTATION FROM A SOLID PHOSPHORUS SOURCE

M. B. SPITZER and S. N. BUNKER (Spire Corp., Bedford, MA) *Applied Physics Letters*, vol. 40, June 1, 1982, p. 976-978. refs (Contract NAS7-100)

A phosphorus ion beam, extracted from a Freeman ion source charged with elemental phosphorus, has been investigated for use in solar cell fabrication. Mass spectroscopy of the beam indicates the absence of both minority-carrier lifetime degrading impurities and hydrogen. The ion beam, without mass analysis, was used for ion implantation of solar cells, and performance for all cells was found to be equivalent to mass-analyzed controls. (Author)

A82-33686

**HIGH CURRENT POST-HYDROGENATED CHEMICAL VAPOR DEPOSITED AMORPHOUS SILICON P-I-N DIODES**

N. SZYDLO, E. CHARTIER, N. PROUST, J. MAGARINO, and D. KAPLAN (Thomson-CSF, Laboratoire Central de Recherches, Orsay, Essonne, France) *Applied Physics Letters*, vol. 40, June 1, 1982, p. 988-990. Research supported by the Commissariat a l'Energie Solaire. refs

The fabrication of amorphous Si p-i-n diodes by means of chemical vapor deposition and post-hydrogenation in a hydrogen plasma has been demonstrated. Current densities of up to 50 A/sq cm, rectification ratios better than 10 million for 3-V applied bias, and a characteristic reversible breakdown voltage of up to about 20 V, are observed through analysis of current-voltage characteristics. Results are compared with those obtained for the case of SiH<sub>4</sub> glow discharge decomposition-prepared amorphous Si p-i-n diodes. O.C.

A82-33714#

**BIAXIAL CYCLIC DEFORMATION AND CREEP-FATIGUE BEHAVIOR OF MATERIALS FOR SOLAR THERMAL SYSTEMS**

S. MAJUMDAR (Argonne National Laboratory, Argonne, IL) *ASME, Transactions, Journal of Pressure Vessel Technology*, vol. 104, May 1982, p. 88-95. Research supported by the U.S. Department of Energy. refs  
(ASME PAPER 82-PVP-74)

A82-33895#

**SOLAR BACTERIAL BIOMASS FARM FOR SPACE VEHICLES**

H. TRIBUTSCH (Berlin, Freie Universitaet, Berlin, West Germany) *Astronautics and Aeronautics*, vol. 20, June 1982, p. 66-68. refs

The use of the bacterium *Thiobacillus ferrooxidans* to produce biomass ten times as efficiently as the best agricultural land is discussed. A solution of Fe(2+), carbon dioxide from the air, and oxygen is all that the bacterium needs to grow and multiply and produce biomass at 35 percent efficiency. Depending on what process is used to manufacture the Fe(2+), the final efficiency would range from 6 to 17.7 percent, compared to the 1 percent efficiency of photosynthesis. A solar farm in space producing biomass by means of a continuous-flow apparatus is described. The bacterium has characteristics suitable for living in outer space: ability to grow in the dark, toleration of harsh living conditions, and resistance to radiation. C.D.

A82-33925#

**SOLAR HEAT COLLECTOR-GENERATOR FOR COOLING PURPOSES**

K. ABDULLAH (Bogor Agricultural University, Bogor, Indonesia) *Regional Journal of Energy Heat and Mass Transfer*, vol. 4, Jan. 1982, p. 19-26; Discussion, p. 26, 27.

The performance of an experimental LiBr-H<sub>2</sub>O solar collector powered absorption cooling system is described. A numerical model was developed of the energy, mass, and momentum balances across the heat-exchange loop to obtain the refrigerant vapor generation rate. The mechanism works by the thermosiphon principle, which eliminates mechanical devices from the loop. All leaks were fixed before measurements began with a test apparatus comprising a pyrex tube 1.87 m long with a 2.7 i.d. The refrigerant flow rate was monitored, along with temperature changes in the fluid and across the tube. Bubble initiation was observed from the free surface extending downward in the tube. Reynolds numbers varied from 6-43 in the liquid phase and 81-204 in the vapor phase. A formulation was made for the low-velocity two-phase flow and good agreement was demonstrated with the simulation. M.S.K.

A82-34076

**SYMPOSIUM ON MATERIALS AND NEW PROCESSING TECHNOLOGIES FOR PHOTOVOLTAICS, HOLLYWOOD, FL, OCTOBER 1980, PROCEEDINGS**

J. A. AMICK, (ED.) (Exxon Research and Engineering Co., Linden, NJ), E. SIRTIL (Heliotronic GmbH, Burghausen, West Germany), P. RAI-CHOUDHURY (Westinghouse Research and Development Center, Pittsburgh, PA), and J. P. DISMUKES (Exxon Research and Engineering Co., Linden, NJ) Symposium sponsored by the Electrochemical Society Pennington, NJ, Electrochemical Society, Inc. (ECS, Proceedings. Volume 81-3), 1981. 355 p \$14

The progress towards establishment of commercially viable, mass production solar cells is examined. Photovoltaic programs carried on by U.S., Japan, and European governments are reviewed, along with candidate methods for producing low cost Si cells. Candidate materials and processes include rice hulls, dendritic web formation, silane pyrolysis and deposition in a fixed bed reactor, and purification during crystal pulling. Attention is given to crystalline solar cells, particularly back surface field and interdigitated back contact Si cells, thin film formation techniques and modeling parameters, and materials for modular array construction. Encapsulant investigations are detailed, as are research programs in CdS, Cu<sub>2</sub>S/CdS, and Be-doped (GaAl)As/GaAs solar cell fabrication. Finally, prototype industrial processes being developed by government-industry cooperation are described. M.S.K.

A82-34077

**SOLAR PHOTOVOLTAIC PROGRAMS IN THE SUNSHINE PROJECT AND PRESENT STATUS OF R&D IN JAPAN**

Y. HAMAKAWA (Osaka University, Toyonaka, Japan) In: Symposium on Materials and New Processing Technologies for Photovoltaics, Hollywood, FL, October 1980, Proceedings. Pennington, NJ, Electrochemical Society, Inc., 1981, p. 18-36. refs

Solar photovoltaic activities in the national technological development program, the 'Sunshine Project' in Japan are introduced. The philosophy, program milestones, technological development plans and their structures are viewed. Present status of solar photovoltaic R&D projects and some recent remarkable results are described. Current trends in the photovoltaic industry and some application systems scheduled for market stimulation are also demonstrated and discussed. (Author)

A82-34078

**CURRENT ASPECTS IN LOW-COST SILICON TECHNOLOGY**

J. DIETL (Heliotronic GmbH, Burghausen, West Germany) In: Symposium on Materials and New Processing Technologies for Photovoltaics, Hollywood, FL, October 1980, Proceedings. Pennington, NJ, Electrochemical Society, Inc., 1981, p. 48-59. Bundesministerium fuer Forschung und Technologie refs  
(Contract BMFT-NT-0845/0846)

The target of worldwide efforts in manufacturing low-cost Si is to provide an impurity-optimized material suitable for large-scale solar cell fabrication. Different new technologies have been developed but apparently obsolete methods have seen their renaissance likewise. The processes use either quartz, metallurgical-grade silicon or volatile halides as the silicon source material. A survey of high-potential processes is given in terms of abundance of resources and low-cost processing. Low energy consumption, high yield, and high through-put are further criteria of the currently most discussed ways to produce terrestrial solar-grade silicon. (Author)

A82-34079

**PURIFICATION OF RICE HULLS AS A SOURCE OF SOLAR GRADE SILICON FOR SOLAR CELLS**

J. A. AMICK (Exxon Research and Engineering Co., Linden, NJ) In: Symposium on Materials and New Processing Technologies for Photovoltaics, Hollywood, FL, October 1980, Proceedings. Pennington, NJ, Electrochemical Society, Inc., 1981, p. 60-67. refs

## 02 SOLAR ENERGY

**A82-34080\*** Jet Propulsion Lab., California Inst. of Tech., Pasadena.

### **RELATIVELY LOW-TEMPERATURE PYROLYSIS OF SILANE IN FREE SPACE**

H. LEVIN (California Institute of Technology, Jet Propulsion Laboratory, Pasadena, CA) In: Symposium on Materials and New Processing Technologies for Photovoltaics, Hollywood, FL, October 1980, Proceedings. Pennington, NJ, Electrochemical Society, Inc., 1981, p. 68-79. refs

The continuous flow pyrolyzer is a free space reactor that is used to study the effects of concentration, flow rate and temperature in making solar-grade silicon by pyrolysis of silane gas. Work with the continuous flow pyrolyzer is within the DOE-sponsored Low-Cost Solar Array Project. The work has led to a new theoretical treatment of silane pyrolysis in free space at relatively low temperatures (550 C to 750 C). It involves a sequential, three-step mechanism of particle growth: first, silicon atom generation by homogeneous reaction; second, coagulation to a 0.1 micron particle due to Brownian motion and van der Waals forces; and finally, chemical vapor deposition by heterogeneous reaction to final particle size. (Author)

**A82-34082**

### **SILICON SHEET - A KEY TO LOW COST SOLAR CELLS**

R. H. HOPKINS (Westinghouse Research and Development Center, Pittsburgh, PA) In: Symposium on Materials and New Processing Technologies for Photovoltaics, Hollywood, FL, October 1980, Proceedings. Pennington, NJ, Electrochemical Society, Inc., 1981, p. 92-107. refs

The levels of advancement of various methods of mass-producing silicon sheets for solar cells are assessed. Indirect methods involve initial formation of the crystal and then sawing to shape. Growth is produced by either the Czochralski method or by directional freezing. Direct methods involve forming the finished cell in a one-step process, and include capillary shaping, dendritic web, ribbon to ribbon, Si on ceramic, horizontal ribbon growth, roller quenching, and filament guided ribbon growth. The production of commercially producible cells by indirect methods is not regarded as possible. The Si on ceramic process called SCIM is mentioned to avoid impurities buildup by passing graphitized mullite substrates through molten Si up to a rate of 30 cm/min. An efficiency of 10.5% was reported in 1980. Automation is noted to be the production snag, especially for Si web and edge-defined growth methods. The latter has yielded 14.5% efficient cells. M.S.K.

**A82-34083**

### **HIGH EFFICIENCY AND RADIATION HARD SOLAR CELLS FROM DENDRITIC WEB SILICON RIBBON**

A. ROHATGI, J. R. DAVIS, P. RAI-CHOUDHURY, R. G. SEIDENSTICKER, and R. B. CAMPBELL (Westinghouse Research and Development Center, Pittsburgh, PA) In: Symposium on Materials and New Processing Technologies for Photovoltaics, Hollywood, FL, October 1980, Proceedings. Pennington, NJ, Electrochemical Society, Inc., 1981, p. 108-118. refs

Features and performance of dendritic web Si solar cells are examined and compared with float zone Si cells. The web is grown between two dendrites withdrawn from molten Si through a freezing slot. Present web-grown wafers contain three (111) twin planes parallel to the surface. Sample npp cells were produced with boron-doping and a resistance of 1-10 ohm-cm, and float zone cells were grown at 850 C for the front junction and 950 C for the back surface field. Current-voltage characteristics of both kinds of cells were studied at 91.6 mW/sq cm illumination under AM1 conditions. The cells were also examined for radiation resistance by exposure to a 1 MeV electron beam and subsequent observations by spectroscopy. Both cells featured a maximum efficiency of 15%, a figure which was slightly higher after oxide passivation treatment. The web and float zone cells tolerated radiation equally. M.S.K.

**A82-34084**

### **METALLURGICAL GRADE SILICON SUBSTRATES FOR SOLAR CELL APPLICATION**

F. SECCO DARAGONA, H. M. LIAW, and D. M. HEMINGER (Motorola, Inc., Phoenix, AZ) In: Symposium on Materials and New Processing Technologies for Photovoltaics, Hollywood, FL, October 1980, Proceedings. Pennington, NJ, Electrochemical Society, Inc., 1981, p. 119-131. refs (Contract XS-9-8119-3)

Sequential steps of purification have been applied to metallurgical grade silicon for the production of low cost Si substrates. The sequential purification includes acid leaching, phase separation, reactive gas treatment, liquid-liquid extraction and impurity redistribution using ingot pulling. The effectiveness of each purification step has been identified. The silicon ingots produced by the sequential purification contain impurity levels at the vicinity of the detection limit of SSMS with the exception of Al, Ti, Ge, P, and B. 7.4% conversion efficiency was obtained for epitaxial solar cells using the purified MG-Si substrates. (Author)

**A82-34085**

### **PHOTOVOLTAIC POWER SYSTEMS - STATE OF THE ART - 1980**

V. K. KAPUR, J. E. AVERY, and C. F. GAY (ARCO Solar, Inc., Chatsworth, CA) In: Symposium on Materials and New Processing Technologies for Photovoltaics, Hollywood, FL, October 1980, Proceedings. Pennington, NJ, Electrochemical Society, Inc., 1981, p. 140-146.

A mass-production process which yields low-cost Si solar cell modules is discussed. Czochralski ingots are grown from semiconductor grade Si and boron is used as the dopant. A resistivity in the range 1-10 ohm-cm in the p-type crystals results and the ingots are sawn to a thickness of 0.015 in. Etching in NaHO eliminates the sawing damage and reduces the reflective losses from 35 to 12%. Phosphorus oxychloride is employed to deposit an n-layer on the wafer. Automated printers deposit silver paste ohmic contacts on the front and aluminum paste on the back surface. Typical I-V curves show a 12.5% efficiency. Polyvinyl butyral sandwiches provide the assembly module of series-connected cells and the entire sheet is imbedded in low-iron glass. Scaling up the process is expected to lower the manufacturing cost to \$3-4/kW. M.S.K.

**A82-34086\*** Applied Solar Energy Corp., City of Industry, Calif.

### **DIAGNOSTIC STUDY OF BSF SILICON SOLAR CELLS**

H. YOO, P. ILES, F. HO (Applied Solar Energy Corp., City of Industry, CA), G. POLLOCK, and K. KOLIWAD (California Institute of Technology, Jet Propulsion Laboratory, Pasadena, CA) In: Symposium on Materials and New Processing Technologies for Photovoltaics, Hollywood, FL, October 1980, Proceedings. Pennington, NJ, Electrochemical Society, Inc., 1981, p. 147-158. NASA-supported research. refs

Solar cells equipped with back surface fields (BSF) were fabricated by means of an aluminum alloy, boron diffusion, and boron ion implantation. The importance of initial thickness, resistivity, orientation, and the crystal growth method were examined. Aluminum in paste form was screen printed on the cell, followed by alloy formation at 800 C for a minute. Application of the BSFs resulted in open circuit voltage improvements dependent on the substrate resistivity, ranging from 10 mV at 0.3 ohm-cm to 50 mV at 15 ohm-cm. The gains in performance were attributed to a longer penetration depth, a heightened concentration profile at the interface, and higher concentrations in the p+ layer. M.S.K.

A82-34087

**PROCESSING FOR HIGH PHOTOCURRENT IN IBC SOLAR CELLS**

F. W. SEXTON, C. M. GARNER, and J. L. RODRIQUEZ (Sandia National Laboratory, Albuquerque, NM) In: Symposium on Materials and New Processing Technologies for Photovoltaics, Hollywood, FL, October 1980, Proceedings. Pennington, NJ, Electrochemical Society, Inc., 1981, p. 159-170. Research supported by the U.S. Department of Energy. refs

The fabrication process and performance characteristics and features of long bulk lifetime, low front and back surface recombination velocities, 10 ohm-cm FZ-grown single crystal Si solar cells are discussed. The cells are interdigitated back contact designs fabricated on 300 microns thick Si wafers, with phosphorus and boron dopants. Quantum efficiency data indicated a minority-carrier lifetime of 350 microsec and a maximum recombination velocity of 30 cm/sec. Laser scans, however, revealed a minimum minority carrier lifetime of 190 microsec. The difference is suggested to be due to front surface recombination reducing the short-circuit current during the laser scans. Back surface passivation is indicated for reducing back surface recombination losses, and a process using 500 Å thick wet thermal oxides is recommended. M.S.K.

A82-34088

**PARABOLIC MODEL FOR OPTIMIZING GRID AND BUS METALLIZATION PATTERNS IN CIRCULAR SOLAR CELLS**

J. A. AMICK and C. FISHMAN (Exxon Research and Engineering Co., Linden, NJ) In: Symposium on Materials and New Processing Technologies for Photovoltaics, Hollywood, FL, October 1980, Proceedings. Pennington, NJ, Electrochemical Society, Inc., 1981, p. 171-186.

A82-34089\* Jet Propulsion Lab., California Inst. of Tech., Pasadena.

**ANALYTICAL CALCULATION OF THICKNESS VERSUS DIAMETER REQUIREMENTS OF SILICON SOLAR CELLS**

C. P. CHEN (California Institute of Technology, Jet Propulsion Laboratory, Pasadena, CA) In: Symposium on Materials and New Processing Technologies for Photovoltaics, Hollywood, FL, October 1980, Proceedings. Pennington, NJ, Electrochemical Society, Inc., 1981, p. 187-195. refs

It may be more cost-effective to produce larger diameter silicon Cz solar cells. However, greater thickness is anticipated to be necessary for larger diameter wafers to withstand wafering, cell processing and handling. No material standard for these dimensional requirements is practical or cost-effective for cell manufacturers. The equations relating wafer thickness and diameter were derived by using fracture mechanics analysis. An analytical model was used as a guideline to estimate thickness versus diameter requirements of silicon solar cells in terms of fracture mechanics parameters. (Author)

A82-34090

**PRACTICAL LIMITING EFFICIENCIES FOR CRYSTALLINE SILICON SOLAR CELLS**

J. A. AMICK and A. K. GHOSH (Exxon Research and Engineering Co., Linden, NJ) In: Symposium on Materials and New Processing Technologies for Photovoltaics, Hollywood, FL, October 1980, Proceedings. Pennington, NJ, Electrochemical Society, Inc., 1981, p. 196-211. refs

A review is given of the factors governing the conversion efficiency for crystalline silicon solar cells at air-mass-1, and of the practical limits on cell efficiencies. Included are losses due to reflection, shadowing, carrier diffusion length, and  $I^2R$  dissipation. The influence of polycrystalline grain size on conversion efficiency is also discussed. For conventional cells having a planar junction, a practical limiting efficiency in production appears to be about 17-18% in the absence of sunlight concentration. (Author)

A82-34091

**LOW-COST PROCESSES FOR THIN-FILM SOLAR CELLS**

R. M. MOORE (Solar Energy Research Institute, Golden, CO) In: Symposium on Materials and New Processing Technologies for Photovoltaics, Hollywood, FL, October 1980, Proceedings. Pennington, NJ, Electrochemical Society, Inc., 1981, p. 212-214. refs

The orientation and goals of a solar cell Exploratory Development program at the Solar Energy Research Institute are described. Thin film photovoltaic manufacturing processes which have shown initial promise for low-cost production of efficient cells will be examined as candidates for entering technology development. Polycrystalline Si was examined initially and succeeding trials will be run with amorphous Si, II-VI, and III-V materials to further define the choice of materials for the process tests. Performance goals are targeted at cells with over 20 sq cm area exceeding an 11% AM1 efficiency and thin film modules with an AM1 output of 8 W. M.S.K.

A82-34092\* Jet Propulsion Lab., California Inst. of Tech., Pasadena.

**ION IMPLANTATION OF SOLAR CELL JUNCTIONS WITHOUT MASS ANALYSIS**

D. FITZGERALD (California Institute of Technology, Jet Propulsion Laboratory, Pasadena, CA) and D. G. TONN (California Institute of Technology, Pasadena, CA) In: Symposium on Materials and New Processing Technologies for Photovoltaics, Hollywood, FL, October 1980, Proceedings. Pennington, NJ, Electrochemical Society, Inc., 1981, p. 215-222. Research sponsored by the U.S. Department of Energy and NASA.

This paper is a summary of an investigation to determine the feasibility of producing solar cells by means of ion implantation without the use of mass analysis. Ion implants were performed using molecular and atomic phosphorus produced by the vaporization of solid red phosphorus and ionized in an electron bombardment source. Solar cell junctions were ion implanted by mass analysis of individual molecular species and by direct unanalyzed implants from the ion source. The implant dose ranged from 10 to the 14th to 10 to the 16th atoms/sq cm and the energy per implanted atom ranged from 5 KeV to 40 KeV in this study. (Author)

A82-34093\* Springborn Labs., Inc., Enfield, Conn.

**PHOTOVOLTAIC ENCAPSULATION MATERIALS**

B. BAUM, P. W. WILLIS (Springborn Laboratories, Inc., Enfield, CT), and E. C. CUDDIHY (California Institute of Technology, Jet Propulsion Laboratory, Pasadena, CA) In: Symposium on Materials and New Processing Technologies for Photovoltaics, Hollywood, FL, October 1980, Proceedings. Pennington, NJ, Electrochemical Society, Inc., 1981, p. 223-260.

Candidate materials for the construction of cost-effective solar cell flat array modules are reviewed. Fabrication goals include electricity production at \$.70/W with a lifetime of 20 yr. Research is currently directed toward low cost encapsulants and substrates for the cells, and outer covers which resist weathering. Ethylene/vinyl acetate copolymer (EVA) at \$.09/sq ft has displayed the most promising results as the encapsulant laminate when subjected to peroxide cross-linking to prevent melting. EVA accepts the addition of antioxidants, quenchers, absorbers, and stabilizers. Wood is favored as the rigid substrate due to cost, while top covers in substrate modules comprise candidate acrylic and polyvinyl fluoride films and a copolymer. Finally, fiberglass mat is placed between the substrate and the EVA pottant as a mechanical support and for electrical insulation. M.S.K.

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**A82-34095**

### **TERRESTRIAL SOLAR MODULES**

W. SAMPSON and S. OLAH (Applied Solar Energy Corp., City of Industry, CA) In: Symposium on Materials and New Processing Technologies for Photovoltaics, Hollywood, FL, October 1980, Proceedings. Pennington, NJ, Electrochemical Society, Inc., 1981, p. 266-270.

Processing methods and materials for the fabrication of solar cell modules are reviewed. It is noted that current production favors copper, particularly in mesh form, as the cell interconnect material due to suitability for stress relief configurations to offset the effects of thermal expansion and deficiencies in the bond between copper and Si. Ethylene vinyl/acetate is preferred to polyvinyl butyral as an encapsulant because it is also a dry film and adheres at low temperature without requiring a pressure bond. The thermal cycling parameters have been set at -40 to 90 C, and tempered low iron, high transmission, water white glass is used as the superstrate. A conceptual design for an automated production of the encapsulated cells is outlined, including the ability to make front and back interconnects and achieve accurate soldering due to the precise location of the solar cells in the process. M.S.K.

**A82-34096**

### **THE ROLE OF BE IN /GAAL/AS/GAAS SOLAR CELLS**

K. MASU, S. NAKATSUKA, M. KONAGAI, and K. TAKAHASHI (Tokyo Institute of Technology, Tokyo, Japan) In: Symposium on Materials and New Processing Technologies for Photovoltaics, Hollywood, FL, October 1980, Proceedings. Pennington, NJ, Electrochemical Society, Inc., 1981, p. 295-303. refs

The fundamental effects of Be diffused into (GaAl)As/GaAs solar cells and also the electrical properties of Be doped layers were examined. The diffusion coefficient in a p-type cell was found to vary with temperature and concentration during formation at 700-900 C in a liquid phase epitaxial process. The thickness of the Be-doped region was also found to vary with the growth temperature, in proportion to the square root of the diffusion time. The van der Pauw method was employed to examine the electrical properties by determining the average resistivity, hole mobility, and free-carrier concentration. The resistivity matched previous results for Zn-doped layers while the acceptor energy level was 47 meV, implying the suitability of the use of Be as a means to reduce the sheet resistance of (GaAl)As/GaAs cells. An electron diffusion length of 4.2 microns was observed for a free-carrier concentration of 10 to the 18th/cu cm. M.S.K.

**A82-34097**

### **THE CLEFT PROCESS - A TECHNIQUE FOR PRODUCING EPITAXIAL FILMS ON REUSABLE SUBSTRATES**

J. C. C. FAN, C. O. BOZLER, and R. W. MCCLELLAND (MIT, Lexington, MA) In: Symposium on Materials and New Processing Technologies for Photovoltaics, Hollywood, FL, October 1980, Proceedings. Pennington, NJ, Electrochemical Society, Inc., 1981, p. 304-311. USAF-supported research. refs

The peeled-film technique called CLEFT is discussed as a means to achieve cost reductions in semiconductor materials for GaAs solar cells. Using vapor-phase epitaxial growth permits cleavage of the epitaxial film from a substrate by first placing a suitable mask, e.g., carbonized photoresist, on the substrate. Photolithographic processes etch strip openings in the carbonized layer. After solidification the epitaxial layer can be cleaved off the weak, carbonized mask. A GaAs single crystal substrate has been used repeatedly and electrical measurements have shown no performance degradation in the deposited film. GaAs films with a thickness of 8 microns formed by the technique have displayed AM1 efficiencies of 15%. Possible fabrication of films 0.1 micron thick are indicated. M.S.K.

**A82-34099\*** Jet Propulsion Lab., California Inst. of Tech., Pasadena.

### **TECHNOLOGY TRANSFER - LSA PROJECT TO INDUSTRY**

B. D. GALLAGHER (California Institute of Technology, Jet Propulsion Laboratory, Pasadena, CA) In: Symposium on Materials and New Processing Technologies for Photovoltaics, Hollywood, FL, October 1980, Proceedings. Pennington, NJ, Electrochemical Society, Inc., 1981, p. 320-325. Research sponsored by the U.S. Department of Energy and NASA.

Program goals, procedural steps, and examples of different situations encountered in the Low-cost Solar Array (LSA) project managed at the Jet Propulsion Laboratory in conjunction with industrial contractors are outlined. The project is intended to result in the production-ready status of photovoltaic panels which produce power at \$.70/peak W by 1986. The first phase of the program identified materials and processes which were promising for further development. Phase II served to correct steps and materials which did not work and were important to the array processing. The third phase will bring the processes to technical readiness by demonstration of successful fabrication of modules at a scale which can be increased to commercial production. An information exchange is ongoing between manufacturers and the JPL to alter specific steps which yield results which vary from those found in the laboratory when transferred to the factory. M.S.K.

**A82-34489**

### **PROPERTIES OF SPRAY-DEPOSITED COBALT OXIDE SELECTIVE COATINGS ON ALUMINIUM AND GALVANISED IRON SUBSTRATES**

C. CHOUDHURY and H. K. SEHGAL (Indian Institute of Technology, New Delhi, India) Applied Energy, vol. 10, Apr. 1982, p. 313-324. refs

A low cost, single step process using spray pyrolysis for the growth of highly adherent and stable cobalt oxide films on commercially available aluminum and galvanized iron to form a flat plate collector selective surface is described. Acetone-degreased substrates were heated into the 150-230 C range and sprayed with  $\text{Co}(\text{NO}_3)_2 \cdot 6\text{H}_2\text{O}$  to deposit the films. Photothermal, electron diffraction, scanning electron microscope, spectrophotometric, and thermal emittance tests were performed on prepared samples. Adhesion was examined by 50 tape-pulling tests for each surface, then twenty more after thermal cycling to 600 and 400 C with aluminum and galvanized iron substrates, respectively. Both coatings were found superior to black paint. The best performance was with substrates kept at 180 C during deposition, with film layers of 0.30 micron on aluminum and 0.32 micron on galvanized iron. M.S.K.

**A82-34540**

### **PREPARATION AND ANALYSIS OF CDS-CU<sub>2</sub>S SOLAR CELLS**

L. MAHDJOURI, M. DERDOURI, and M. BENMALEK (Organisme National de la Recherche Scientifique, Centre des Sciences et de la Technologie Nucleaires, Algiers, Algeria) (Thin Film Solar Cells Meeting, Newcastle-upon-Tyne Polytechnic, Newcastle-upon-Tyne, England, Apr. 1981.) Solar Cells, vol. 5, Mar. 1982, p. 205-212. refs

The fabrication steps and performance characteristics of CdS-layers for CdS-Cu<sub>2</sub>S solar cells are detailed. CdS was evaporated on a graphite source at source and substrate temperatures of 1050 and 200 C, respectively. An Au-CdS Schottky diode was also formed by thermally depositing a 1000 A thick layer of gold onto the CdS layer. Samples were prepared with the Au coating directly from vacuum, after etching in HCl, and by performing the whole process in a vacuum. The cells were then dipped in a CuCl solution at 90 C for 5 sec to form a p-type Cu<sub>2</sub>S layer. The CdS cell layer has an absorption spectrum in the range 2.36-2.44 eV with a c-axis in perpendicular orientation to the substrate. An additional heat treatment of 200 C for 3 min was found to enhance the cell efficiency by changing the Cu(x)S phases to Cu<sub>2</sub>S at the interface. Further work is indicated on the growth of the Cu<sub>2</sub>S growth step. M.S.M.

A82-34541

**PHOTOVOLTAIC PERFORMANCES OF CU<sub>2</sub>S/CDS SPRAYED SOLAR CELLS**

M. SAVELLI, J. BOUGNOT, H. LUQUET, M. PEROTIN, O. MARIS, and C. GRIL (Montpellier II, Universite, Montpellier, France) (Thin Film Solar Cells Meeting, Newcastle-upon-Tyne Polytechnic, Newcastle-upon-Tyne, England, Apr. 1981.) Solar Cells, vol. 5, Mar. 1982, p. 213-229. refs

The fabrication and results of optimization tests on sandwich Cu<sub>2</sub>S/CdS solar cells with an indium-tin-oxide (ITO) layer are reported. The cells were formed in a chemical spray deposition process, producing succeeding layers of Cu, Cu<sub>2</sub>S, CdS, CdS doped Al, ITO, and pyrex. The ITO displayed a constant transmission efficiency as a transparent electrode, with transparency being optimized around 90 percent with a sheet resistance of 7 ohms. The ITO layer thickness was optimized by examining the current-voltage curves, leading to a 0.4 micron edge causing a minimized 8 percent loss to the cell efficiency. The best growth rate of the CdS film was determined to be 2 microns/h with a substrate temperature of 400 C. The cell displayed a maximum efficiency of 7.4 percent and a maximum response with a 0.55 micron thick front layer. Further work to optimize the CdS transparency, reduce the interface states, and improve the performance after encapsulation is indicated. M.S.K.

A82-34542

**SINGLE-CRYSTAL ZN/X/CD/1-X/S/CU<sub>2</sub>S PHOTOVOLTAIC CELLS**

S. OKTIK, G. J. RUSSELL, and J. WOODS (Durham, University, Durham, England) (Thin Film Solar Cells Meeting, Newcastle-upon-Tyne Polytechnic, Newcastle-upon-Tyne, England, Apr. 1981.) Solar Cells, vol. 5, Mar. 1982, p. 231-241. refs

Results of an investigation of the performance characteristics of ZnCdS/Cu<sub>2</sub>S solar cells are reported. Single crystal cells were grown with a Zn contribution between 0-0.4 and resistivities ranging from 0.5-2.0 ohm-cm. An In ohmic contact was placed on the Cd base plane and the CuS layer was formed on the sulfur layer by means of the wet-plating method. I-V characterization under 100 mW/sq cm illumination revealed that the open-circuit voltage increased with the Zn content while the short-circuit current and the fill factor decreased. Cell baking in air at 200 C had a less beneficial effect with the increasing Zn content. Spectral response examinations revealed that the major response occurred at peaks of 0.7 and 0.96 microns regardless of the composition of the substrate, and electron diffraction studies linked the responses to the formation of chalcocite and djurleite. Finally, it is noted that baking at 200 C for 4 min shifted the response peaks toward lower wavelengths. M.S.K.

A82-34543

**TRENDS AND PROBLEMS IN CDS/CU/X/S THIN FILM SOLAR CELLS - A REVIEW**

S. MARTINUZZI (Aix-Marseille III, Universite, Marseille, France) (Thin Film Solar Cells Meeting, Newcastle-upon-Tyne Polytechnic, Newcastle-upon-Tyne, England, Apr. 1981.) Solar Cells, vol. 5, Mar. 1982, p. 243-268. refs

The methods currently used to fabricate CdS/CuS solar cells are reviewed, along with comparisons of the effects on performance of the various preparation techniques. Attention is given to thermal evaporation, sputter, and chemical spray formation of the CdS layers, noting that most experience is presently with the evaporative and spray processes. CuS layers are formed in dip or wet process chemiplating, electroplating, vacuum deposition in flash and sputter modes, solid state reaction, or spray deposition. Any of the CuS film techniques can be used with any of the CdS layer processes, while spraying and sputtering are noted to offer the best alternatives for industrial production. Band profiles, I-V characteristics, photocurrent levels, and capacitance-voltage characteristics are outlined for the differently formed cells, and CdS/CuS and CdZnS/CuS cells are concluded to exhibit the highest performance features. Areas of improvement necessary to bring the cells to commercial status are discussed. M.S.K.

A82-34544

**SIMULATION OF THE BEHAVIOUR OF A SET OF CU<sub>2</sub>S-CDS UNIT PHOTOCELLS**

J. L. JACQUEMIN and G. BORDURE (Montpellier II, Universite, Montpellier, France) Solar Cells, vol. 5, Mar. 1982, p. 269-274.

A computer model was employed to simulate the performance of a panel of 30 solar cells in order to determine the contribution expected from the individual cells. The cells array was modeled on the bases of series and parallel resistance, saturation current density, short-circuit current, and the number of cells. I-V curves were calculated for the mean performance of a batch of thirty cells and the performance of the best cell produced in the batch. Substituting low efficiency cells in a normal parallel array was found to potentially seriously degrade the performance of the whole array. The most important parameters determining the array performance were determined to be the efficiency, open-circuit voltage, short-circuit current, and the saturation current, while the number of cells, resistances, and the fill factors did not significantly impinge on the array output. M.S.K.

A82-34545

**INEFFECTIVENESS OF LOW-HIGH JUNCTIONS IN OPTIMIZED SOLAR CELL DESIGNS**

H. T. WEAVER (Sandia National Laboratory, Albuquerque, NM) Solar Cells, vol. 5, Mar. 1982, p. 275-292. Research supported by the U.S. Department of Energy. refs

An attempt to prove that conventional Si solar cells (CV) are as promising as the developmental goals for back-surface field (BSF) and low substrate resistivity high-low emitter (HLE) cells is presented. The work is focused on 300 microns thick pnn and ppn cells, the generic type of CV cells currently available. Governing differential equations are presented to model cell performance in terms of numerical solutions to the transport equations. It is noted that the only difference between CV cells and BSF cells is that CV cells do not have rear surface diffusion. Configuring the cells to take full advantages of the BSF feature results in a cell with much the same efficiency of a CV cell, except under either concentration modes or with 50 microns thick thin cells. Finally, an HLE cell with a 10-25 microns thick layer doped to 10 to the 16th/cu cm can offer only a minor efficiency increase over the best available CV cells. M.S.K.

A82-34546

**THE EFFECTS OF NON-UNIFORM ILLUMINATION OF SOLAR CELLS WITH CONCENTRATED LIGHT**

H. PFEIFFER and M. BIHLER (Maschinenfabrik Augsburg-Nuernberg AG, Munich, West Germany) Solar Cells, vol. 5, Mar. 1982, p. 293-299. Research supported by the Commission of the European Communities and Bundesministerium fuer Forschung und Technologie. refs

Experimental results for trials to determine the effects of nonuniform illumination and varying the intensity of illumination on solar cells connected in series in a concentrator configuration are presented. A simulator with 9000 W/sq m was used to test 5 x 5 cm Si cells in factor of 10 concentrator configurations. Cells were subjected to uniform lighting with filters to control and outer 1 cm edge illumination and in another trial where whole cells were deprived of light by a filter. The filters were calibrated to have transmission factors of 89, 56, 44, and 21%. Losses due to uneven illumination were a maximum of 3%, even with a 50% variance in concentration. Totally blocking light to a cell in a series stopped the whole generator's output, while a 10% difference in light to two cells resulted in only a 2% power loss. Neither site nor geometry exhibited any effect on the output. It is concluded that shape standards for concentrators can be relaxed. M.S.K.

A82-34551

**THEMIS - A SOLAR POWER STATION [THEMIS - LA CENTRALE SOLAIRE]**

J. HILLAIRET (Electricite de France, Marseille, France) Entropie, vol. 18, no. 103, 1982, p. 6-10. In French.

The organization, goals, equipment, costs, and performance of the French Themis (Thermo-helio-electric-MW) project are outlined.

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The program was begun for both the domestic energy market and for export. The installation comprises a molten eutectic salt loop which receives heat from radiators situated in a central tower. The salt transfers the heat to water for steam generation of electricity. A storage tank holds enough molten salt to supply one day's reserve of power, 40 MWh. A field of heliostats directs the sun's rays for an estimated 2400 hr/yr onto the central receiver aperture, while 11 additional parabolic concentrators provide sufficient heat to keep the salt reservoir at temperatures exceeding 200 C. In a test run of several months during the spring of 1982 the heliostats directed the sun's rays with an average efficiency of 75 percent, yielding 2.3 MW of power at a system efficiency of 20.5 percent in completely automatic operation. M.S.K.

**A82-34552**

### **THE THEMIS HELIOSTAT FIELD [LE CHAMP D'HELIOSTATS DE THEMIS]**

A. COLLON (Electricite de France, Marseille, France) and A. LECLERC (CETHEL, Neuilly-sur-Seine, Hauts-de-Seine, France) *Entropie*, vol. 18, no. 103, 1982, p. 10-20. In French.

The 201-heliostat field which supplies solar rays to the central receiver as part of the Themis project is detailed. Each heliostat has 54 sq m of surface and is connected with all others in a central control circuit. The energy is directed to a square aperture 4 m on a side. The control logic is written in three levels, with microprocessors located in each heliostat drive to follow commands of a central computer. The reflector field is subsequently divided into zones in order to maximize control efficiency and power deposition on the receiver as the day progresses. A maximum of 9.7 MWth is shone on the power tower at an operational efficiency of 77 percent. A cylindrical shape was chosen for the array, which turns face downward to survive in strong winds. Emergency procedures which would also cause the plant to shut down due to an accident in the primary loop are explored, along with hazards to human eyesight from seeing the reflected flux. M.S.K.

**A82-34553**

### **THE THEMIS SOLAR RECEIVER [LE RECEPTEUR SOLAIRE THEMIS]**

J. M. GRAVRAND (Constructions Navales et Industrielles de la Mediterranee, La Seyne-sur-Mer, Var, France) and X. POUGET-ABADIE (Electricite de France, Marseille, France) *Entropie*, vol. 18, no. 103, 1982, p. 20-29. In French. refs.

The theoretical modeling, materials, and design of the central receiver heat exchanger on the tower of the Themis solar power plant are presented. The receiver was conceived based on the incident solar flux at different times of the day and year and the efficiency of transferring the heat to molten salts. The square aperture admits energy at a peak rate of 3.402 MWth at some points, with heat transfer to the power loop resulting in a maximum efficiency of 25 percent. Optimization studies indicated a receiver inclined 30 deg from the horizontal to face the heliostat field, and the flux incident on the walls was mapped. Tubes filled with the salts at 250 C form the walls behind radiator fins and elevate the salt to temperatures up to a limit of 490 C. Measures taken to allow for the expansion of the cavity walls and to mount the heat exchange tubes for easy replacement are described, along with the instrumentation to measure performance, flux, and detect malfunctions due to perturbations in the fluid flow or failure of any of the components. M.S.K.

**A82-34554**

### **THE THERMODYNAMIC CONVERSION OF SOLAR ENERGY - TECHNICAL AND ECONOMIC COMPARISON OF DIFFERENT POWER PLANTS [CONVERSION THERMODYNAMIQUE DE L'ENERGIE SOLAIRE - COMPARAISON TECHNIQUE ET ECONOMIQUE DE DIFFERENTES FILIERES]**

C. ETIEVANT (CNRS, GESER, Chatenay-Malabry, Hauts-de-Seine, France) and M. ROCHE (Electricite de France, Direction des Etudes et Recherches, Chatou, Yvelines, France) *Entropie*, vol. 18, no. 103, 1982, p. 30-47. In French. refs.

An examination of the costs, materials, and construction of various solar-thermal power plants is made, starting from data

derived from fabrication and operation of the Themis power plant. The cycles considered include steam generation, eutectic or draw salts, molten sodium and air, and air, powered by flux from a central receiver or by multiple parabolic concentrators. All designs involve a scaling up of the 1 MW Themis plant to at least 10 MWe, and gas generator systems, using, e.g., helium, are regarded as feasible only with a few tens of MWe output. The systems are discussed in terms of the components and performance of the primary circuit, heat storage, and the efficiency of the thermodynamic cycle. Optimizing the heliostats is shown to be necessary in order to reduce costs and required units. It is concluded that higher temperatures are necessary for economical application, and that heat storage must be included. M.S.K.

**A82-34555**

### **POWER PLANT I - FUSED SALT [FILIERE I - SEL FONDU]**

M. ROCHE (Electricite de France, Direction des Etudes et Recherches, Chatou, Yvelines, France) *Entropie*, vol. 18, no. 103, 1982, p. 48-52. In French.

A solar thermal power plant using fused salt as the heat transfer fluid for steam power generation is analyzed for the feasibility of economic operation. The salt is also stored in a tank reservoir for maintaining the primary heat loop at temperatures high enough for the salts to remain liquid, and also to provide reserve power for the steam generator. Initial studies were with eutectic (hitec) salt comprising Na, KOH, and nitrites melting at 146 C, and further studies were performed employing draw salt, which has no nitrite, is more stable at high temperature, and melts at 225 C. The use of draw salt was found to allow a 5 percent reduction in storage capacity. Further examinations of the effects of the hitec salts on corrosion and composition degradation at high temperatures are indicated. The molten salt system is projected to offer an efficiency of 26 percent. M.S.K.

**A82-34556**

### **POWER PLANT II - SODIUM-WATER [FILIERE II - SODIUM-EAU]**

M. ROCHE (Electricite de France, Direction des Etudes et Recherches, Chatou, Yvelines, France) *Entropie*, vol. 18, no. 103, 1982, p. 53-57. In French.

The implementation of a sodium based heat exchange loop is presented as a means of reducing the required size of a solar thermal power plant heat exchanger. Sodium as a heat transfer fluid allows operations near 535 C with electromagnetic pumps. It is noted that sodium must be completely sealed in and surrounded with a neutral gas such as nitrogen or argon. The higher temperatures pave the way for a more efficient thermodynamic cycle, although the Themis receiver would necessarily need a faster loop in addition to more absorbent surfaces to adequately handle the sodium liquid. The steam lines would be helically wound in a chamber through which the sodium flows linearly downward. Storage is concluded to not be feasible under current technology due to the violent reactions possible between sodium and water or hitec salts. An auxiliary heat source would be required. M.S.K.

**A82-34557**

### **POWER PLANT III - STEAM [FILIERE III - EAU-VAPEUR]**

M. ROCHE (Electricite de France, Direction des Etudes et Recherches, Chatou, Yvelines, France) *Entropie*, vol. 18, no. 103, 1982, p. 58-62. In French.

The projected principal components, performance, and costs associated with a direct cycle steam generating solar thermal power plant producing over 10 MWe are examined. Calculations are given for a location in south France, using heliostat and heat exchanger technology developed for Themis. The heat exchanger would have vertical tubes on the side walls for natural circulation, with superheater channels at the top composed of austenitic steels. Temperature of the superheated steam could be regulated by injections of liquid water. Maintaining the pressure during the passage of clouds is taken to require the presence of an auxiliary boiler burning fossil fuels, since no method is presently known of storing latent heat at over 300 C. Approaching clouds would have

to be detected in order to stop the heliostats and ignite the back-up systems. M.S.K.

#### A82-34558

**POWER PLANT IV - THEM-THEK [FILIERE IV - THEM-THEK]**  
M. PONS (CNRS, GESER, Chatenay-Malabry, Hauts-de-Seine, France) Entropie, vol. 18, no. 103, 1982, p. 63-70. In French.

A 10 MWe solar thermal hybrid central receiver-parabolic concentrator power plant is described. The THEK field of parabolic concentrators is employed to preheat and vaporize the water for heating the primary loop, while the THEM central receiver receives solar flux input from a field of heliostats to superheat fused salt, hitec, for the steam-powered generation of electricity. The preheat system also serves to maintain latent heat in the fused salt reservoir. An extra bypass with separation allows the vaporized portion of salt to return to the superheater as condensed salt descends to the reservoir to gain heat, thereby increasing the system efficiency by 8 percent to 33.8 percent. The power unit is coupled to turbines spinning at 9000 rpm. The central aperture closes during cloudy conditions to avoid heat losses in the primary loop. M.S.K.

#### A82-34559

**POWER PLANT V - THEK GENERATING STATION [FILIERE V - CENTRALE THEK]**

M. PONS (CNRS, GESER, Chatenay-Malabry, Hauts-de-Seine, France) Entropie, vol. 18, no. 103, 1982, p. 71-75. In French.

The design and operating features of a 10 MWe parabolic dish concentrator steam-cycle generating plant are described. The dishes which have 75 sq m area with a concentration factor of 265, were proved in the Themis project. The total field for the 10 MWe would cover 63,100 sq m and require 842 units. Using a water-steam cycle at 50 bars, temperature would never surpass 264 C, with an after-generator condition of 33 bars at 204 C. Preheating the water is intended with a fused salt reservoir containing 570 tons in 350 cu m container, around which condensed water would flow. Maintaining the primary loop at mildly elevated temperatures would permit uninterrupted operation during cloudy periods. A total shutdown would occur if cloudy conditions last more than one hour, and start-up would involve reheating the primary loop, recharging the storage, and then respinning the turbine. M.S.K.

#### A82-34560

**POWER PLANT VI - SODIUM-AIR [FILIERE VI - SODIUM-AIR]**  
R. GENIER (Electricite de France, Direction des Etudes et Recherches, Chatou, Yvelines, France) Entropie, vol. 18, no. 103, 1982, p. 76-80. In French.

A sodium-air cycle central receiver solar electric generating plant is described. The system is designed for liquid sodium to be heated to 750 C in the central receiver heat exchangers, pumped down to the tower base to transfer heat to an air loop, then be returned to the receiver aperture. The air loop would heat to 730 C, insufficient for efficient operation of turbines, and would require a further heating by a supplementary burner to temperatures of 950 C. An efficiency of 35.4 percent is projected for a total output of 10,620 kW. The flux is furnished by a field of 743 heliostats with a total surface area of 36,425 sq m, and received by a tower 120 m tall outfitted with a receiver inclined 45 deg from the horizontal. The sodium-air heat exchange is envisioned to take place in a tank of air interpenetrated by continuous, closed, boustrophedonic loops filled with superheated sodium. M.S.K.

#### A82-34561

**POWER PLANT VI REVISITED - SODIUM-AIR /A GRID-BOILER/ [FILIERE VI BIS - SODIUM-AIR /CHAUDIERE A GRILLE/]**

M. ROCHE (Electricite de France, Direction des Etudes et Recherches, Chatou, Yvelines, France) Entropie, vol. 18, no. 103, 1982, p. 81-85. In French.

A configuration which allows operation of a sodium-air dual-loop central receiver at elevated cycle temperatures is presented. The heliostat field covers an area of 43,000 sq m for directing a flux of 23,260 kWth to the power tower aperture. The front of the

receiver contains part of a closed sodium loop, which is also directed into a heat exchanger chamber where energy is transferred to a rising column of air used to turn the generators. The air enters the chamber at 292 C, is heated to 700 C, flows on to the back of the receiver enclosure where the temperature is raised to 850 C, and then on to a turbine generator. Supplemental fossil fueled heat may be necessary to maintain the higher temperatures in unfavorable conditions. A plant with a total output of 7720 kW operating at 33.75 percent efficiency is considered feasible.

M.S.K.

#### A82-34562

**POWER PLANT VII - AIR-AIR /TUBE BOILER/ [FILIERE VII - AIR-AIR /CHAUDIERE A TUBES/]**

M. ROCHE (Electricite de France, Direction des Etudes et Recherches, Chatou, Yvelines, France) Entropie, vol. 18, no. 103, 1982, p. 86-90. In French.

An attempt to design a solar thermal electric central receiver power plant in the multi-MW size with acceptable efficiencies using air in the power loop is described. The turbine and generator are placed in the tower to reduce heat losses in the superheated gas, and the depleted gas loop is coupled to a low temperature generator powered by boiling water. The receiver cavity is configured to retain a maximum amount of flux and has brick walls. Nickel alloys are indicated for the air tubes in the receiver, with Inconel 601, Incoloy 800, and Inconel 600 considered acceptable. The gas leaving the chamber will be at 950 C to power a high pressure turbine, followed by entrance into a heat exchanger to boil the water for the low-pressure turbine, and is then discharged. Thermodynamic efficiencies between 13.9-20.3 percent for a 4700 kW plant are considered feasible with the design. M.S.K.

#### A82-34563

**POWER PLANT VII REVISITED - AIR-AIR /SCIROCCO/ [FILIERE VII BIS AIR-AIR /SIROCCO/]**

C. ETIEVANT (CNRS, GESER, Chatenay-Malabry, Hauts-de-Seine, France) and D. ROYER (Commissariat a l'Energie Atomique, Centre d'Etudes Nucleaires de Saclay Gif-sur-Yvette, Essonne, France) Entropie, vol. 18, no. 103, 1982, p. 91-97. In French.

A hybrid fossil fuel-solar central receiver power plant is described, noting principally a 'Scirocco' configuration for the receiver. The primary loop contains air which enters passages in the alveolar-configured walls of the boiler, which is semi-spherically shaped. The alveoles are located in the back of the cavity while the upper and lower surfaces are reflective. A heat flux of 24.4 MWth is delivered to the aperture by 668 heliostats, each having a 53 sq m surface. Air is heated to 660 C and then flows past flame tubes to attain temperatures near 900 C through use of a combustor before impinging on the turbine blades. It is noted that although only 1000 hr of functioning are currently available for the Scirocco configuration, it offers the chance to reduce the size of the boiler. Further studies to optimize the materials for the boiler are indicated. M.S.K.

#### A82-34564

**ANNUAL PRODUCTIVITY OF A SOLAR THERMOELECTRIC POWER PLANT [BILAN ANNUEL DE CENTRALES HELIOTHERMOELECTRIQUES A CONCENTRATION]**

B. RIVOIRE (CNRS, GESER, Chatenay-Malabry, Hauts-de-Seine, France) Entropie, vol. 18, no. 103, 1982, p. 98-103. In French.

#### A82-34565

**STATE OF THE ART IN SOLAR THERMOELECTRIC POWER PLANT RESEARCH [ETAT DES RECHERCHES SUR LES CENTRALES SOLAIRES DE PUISSANCE DANS LE MONDE]**

C. ETIEVANT (CNRS, GESER, Chatenay-Malabry, Hauts-de-Seine, France) Entropie, vol. 18, no. 103, 1982, p. 104-115. In French. refs

World wide research efforts to develop multi-MW solar central receiver thermoelectric power plants are outlined, noting that only this form of solar energy, coupled with storage, permits adjusting output to meet loads. Among the systems described, which are

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all heliostat-tower configurations, are the 500 kWe SSPS-CRS of the IEA located in southern Spain, the Eurelios station producing 1 MWe on Sicily, and the 1 MWe CESA-1 plant at Tabernas, Spain. Descriptions are also given of the 1 MWe installation at Nio, Japan, the Themis project in France with an output of 2000-2500 MWe, the Soviet CES-5 5 MWe power plant in Lenino on the shore of the Sea of Azov, and the 10 MWe Solar-1 project in Barstow, CA. The systems employ hot air, steam, sodium, or fused salt as heat exchanger fluids, and are being tested for use in producing grid-quality electricity, industrial heat, combustible liquids, and to repower fossil-fuel fed generator cycles. M.S.K.

**A82-35246**

### **RF SPUTTERED GOLD-AMORPHOUS SILICON SCHOTTKY-BARRIER DIODES**

L. XU, D. K. REINHARD (Michigan State University, East Lansing, MI), and M. G. THOMPSON (Michigan Technological University, Houghton, MI) IEEE Transactions on Electron Devices, vol. ED-29, June 1982, p. 1004-1008. refs  
(Contract NSF ENG-79-10896)

Gold Schottky-barrier diodes formed on reactively sputtered amorphous silicon thin films have been investigated. Device forward I-V characteristics are well modeled as a Schottky diode in series with a temperature activated series resistor. At 300 K, the forward current indicates a diode correction factor of 1.4 and a saturation current of  $5.8 \times 10$  to the  $-10$ th A/sq cm. The metal-semiconductor barrier height is 0.93 eV. Capacitance versus frequency measurements indicate a depletion region thickness of 3000 Å. In the depletion region, the mobility-lifetime products are estimated to be of the order of  $5 \times 10$  to the  $-11$ th sq cm/V which is substantially less than the value of  $10$  to the  $-7$ th sq cm/V in the quasi-neutral region. It is suggested that deep gap states are responsible for this difference. Carrier recombination in the depletion region limits the photovoltaic performance. (Author)

**A82-35247**

### **NEW EXPERIMENTAL EVIDENCE FOR MINORITY-CARRIER REFLECTION AT NEGATIVE-BARRIER MIS CONTACTS**

N. G. TARR, D. L. PULFREY (British Columbia, University, Vancouver, Canada), P. A. ILES (Applied Solar Energy Corp., City of Industry, CA), and A. NEUGROSCHER (Florida, University, Gainesville, FL) IEEE Transactions on Electron Devices, vol. ED-29, June 1982, p. 1018-1021. refs

Recently, measurements of the open-circuit voltage of solar cells with negative-barrier metal-insulator-semiconductor (MIS) back contacts have been used to demonstrate that such contacts can function as the electrical analogues of metallurgical high-low junctions. In this brief, further experimental evidence for the minority-carrier reflecting properties of the negative-barrier MIS junction is presented. First, it is shown that a negative-barrier Mg-SiO(x)nSi back contact can be used to enhance the long-wavelength photoresponse of p(+)n solar cells in the same manner as a diffused n(+) back-surface field. Secondly, measurements of the effective surface-recombination velocity for an Mg-SiO(x)-nSi contact and for a diffused n-n(+) high-low junction formed on an identical substrate are reported. Both junctions gave very low values of recombination velocity, on the order of 50 cm/sec. (Author)

**A82-35496**

### **GRAIN BOUNDARY RECOMBINATION ANALYSIS OF GAAS SCHOTTKY BARRIER SOLAR CELLS**

R. J. SOUKUP and G. P. BARTUNEK (Nebraska, University, Lincoln, NE) Journal of Applied Physics, vol. 53, June 1982, p. 4428-4434. refs

A cylindrical grain is used to model the short circuit current density of a thin film polycrystalline GaAs Schottky barrier solar cell. Both backwall and frontwall solar cells are considered and it is found that the optimum thickness for either cell is less than 2.5 microns if reflection of solar energy from the back metallic contact is considered. The grain size and grain boundary recombination velocity affects each cell in the same way. However, the ohmic contact recombination velocity has a greater influence on the

backwall solar cell. The conclusion of this study is that although the backwall cell is potentially more efficient, the frontwall cell is less influenced by semiconductor and contact parameter variation and thus, for production quantities, the frontwall cell will yield more consistent results. (Author)

**A82-35500**

### **MODIFICATION OF OPEN-CIRCUIT VOLTAGE OF METAL-INSULATOR-SEMICONDUCTOR SOLAR CELLS DUE TO A NONUNIFORM INSULATING LAYER**

H. L. CHAU and Y. C. CHENG (University of Hong Kong, Hong Kong) Journal of Applied Physics, vol. 53, June 1982, p. 4544, 4545.

The effect of nonuniformity of the insulating layer on metal-insulator-semiconductor, open-circuit voltage is examined. It is based on a simplified model in which insulator limits the dark current via different effects. The enhancement in open-circuit voltage could be greatly degraded by surface roughness. (Author)

**A82-35501**

### **BASIC RESEARCH NEEDS AND OPPORTUNITIES ON INTERFACES IN SOLAR MATERIALS; PROCEEDINGS OF THE WORKSHOP, DENVER, CO, JUNE 30-JULY 3, 1980**

A. W. CZANDERNA, (ED.) (Solar Energy Research Institute, Golden, CO) and R. J. GOTTSCHALL (U.S. Department of Energy, Office of Basic Energy Sciences, Washington, DC) Workshop sponsored by the U.S. Department of Energy. Materials Science and Engineering, vol. 53, Apr. 1982, 178 p.

Research areas, instrumentation, and existing theoretical models for solid-solid, solid-liquid, and solid-gas interfaces which exist as part of solar energy conversion devices (SECS) are examined. The devices require a thirty-year operative lifetime in order to acquire economic viability. Degradation processes can occur during manufacturing and/or operation of SECS, and performance improvements are available only through increasing mechanical, chemical, atomic, and electronic characterization of microscopic properties and topologies of converters. Attention is given to instrumentation which extends the ability to model the atomic behaviors of interfacial layers of solar devices such as heliostats, solar cells, wind turbine blades, absorbers, and concentrator mirrors, including Auger electron microscopy, reflection absorption IR, electron energy loss spectroscopy, etc. Specific attention is given to vapor-deposition manufacturing processes. M.S.K.

**A82-35502**

### **OVERVIEW OF SOLAR ENERGY CONVERSION TECHNOLOGIES - QUANTUM PROCESSES AND THERMAL PROCESSES**

P. J. CALL (Solar Energy Research Institute, Golden, CO) (U.S. Department of Energy, Workshop on Basic Research Needs and Opportunities on Interfaces in Solar Materials, Denver, CO, June 30-July 3, 1980.) Materials Science and Engineering, vol. 53, Apr. 1982, p. 7-16. refs

**A82-35503**

### **DESIGN REQUIREMENTS FOR INTERFACES IN SOLAR ENERGY CONVERSION TECHNOLOGIES**

B. L. BUTLER (Solar Energy Research Institute, Golden, CO) (U.S. Department of Energy, Workshop on Basic Research Needs and Opportunities on Interfaces in Solar Materials, Denver, CO, June 30-July 3, 1980.) Materials Science and Engineering, vol. 53, Apr. 1982, p. 17-24. refs

Candidate materials for improving the durability and economics of solar energy conversion systems (SECS) are reviewed. A 30-yr lifetime is regarded as necessary for solar collector and concentrator materials in order to offset the high initial costs of SECS in parabolic dish, heliostat, parabolic trough, flat plate collector, OTEC, solar cell, and wind turbine configurations. The materials are required to transfer a maximum amount of intercepted energy without degrading from exposure to UV radiation, wind, water, dust, and temperature cycling. Glass and mirrored surfaces

for reflecting or refracting optical subsystems are currently made from soda-lime, boro- and aluminosilicate, and must resist chemicals, abrasion, and permeability, and have good strength, flexibility, coefficient of expansion, and Young's modulus. Additional concerns are present in photochemical, solar cell, and in substrate components and systems. M.S.K.

#### A82-35505

##### OVERVIEW OF THE CURRENT STATUS OF SOLID-LIQUID INTERFACE SCIENCE

J. O'M. BOCKRIS (Texas A & M University, College Station, TX) (U.S. Department of Energy, Workshop on Basic Research Needs and Opportunities on Interfaces in Solar Materials, Denver, CO, June 30-July 3, 1980.) Materials Science and Engineering, vol. 53, Apr. 1982, p. 47-64. refs

The effectiveness of present techniques for examining the solid-liquid (S-L) interface in photoelectrochemical devices is reviewed. The S-L interface is presently modeled using the Guoy layer theory, although statistical deficiencies are present due to the large number of species to be modeled. The development of ellipsometric spectroscopy for studies in the visible and UV is recommended, along with electrocapillary thermodynamics, the zero charge potential as a parameter, spectroscopy, and the formation of a quantum electrochemical framework. Experimental methods are needed for measuring individual ionic concentrations 10-100 nm from the solid surface, and to determine the structure of H<sub>2</sub>O at the doublelayer Adsorption at the S-L interface is examined by sweep methods which expose the effects of varying the current and the potential. Present methods for studying the diffuse layer are limited to concentrations of 0.001 M or below. Monte Carlo techniques are needed at higher particle numbers. M.S.K.

#### A82-35506

##### OVERVIEW OF THE CURRENT STATUS OF SOLID-GAS INTERFACE SCIENCE

R. S. HANSEN (U.S. Department of Energy, Ames Laboratory, Ames, IA) (U.S. Department of Energy, Workshop on Basic Research Needs and Opportunities on Interfaces in Solar Materials, Denver, CO, June 30-July 3, 1980.) Materials Science and Engineering, vol. 53, Apr. 1982, p. 65-71. refs

The state-of-the-art in techniques for evaluating solid-gas interfaces is assessed, with an emphasis on processes relevant to solar technology. Electron and ion spectroscopy have aided in determining the interface chemical composition, although limitations due to vacuum requirements and surface effects, such as a variation of chemical composition with depth. Uncertainties can then result in a chemical analysis based on the kinetic energy of an emitted electron, which must pass through the inhomogeneously composed layers. The S-G interface techniques are applied to solar cell formation by modeling the optimum thicknesses and compositions of layers of built-up cells. Further use could be made in determining the changes in surface elements with time. M.S.K.

#### A82-35507

##### LIMITATION OF EXPERIMENTAL CAPABILITIES FOR INTERFACIAL STUDIES

D. LICHTMAN (Wisconsin, University, Milwaukee, WI) (U.S. Department of Energy, Workshop on Basic Research Needs and Opportunities on Interfaces in Solar Materials, Denver, CO, June 30-July 3, 1980.) Materials Science and Engineering, vol. 53, Apr. 1982, p. 73-79. refs

Surface analysis techniques for evaluating the interfacial areas in solar cells, mirrors, flat plates, etc. are reviewed. Auger electron spectroscopy is employed for solid-gas and solid-solid interface studies but can cause changes in the surface composition. Ion probes similarly can cause destruction of the substrate. Surface morphology is investigated with scanning electron microscopy up to a resolution of 10 nm. In all cases additional techniques are necessary to measure the exact location of beam traverse. The identification of neighboring components and lateral distributions depends on the use of low energy excitation diffraction, extended X ray fine structure spectroscopy, and electron energy loss

spectroscopy. The development of techniques for exploring the distributions of individual atoms is indicated. M.S.K.

#### A82-35509

##### BASIC RESEARCH NEEDS AND OPPORTUNITIES AT THE SOLID-SOLID INTERFACE - DIFFUSION

R. W. BALLUFFI (MIT, Cambridge, MA), C. B. DUKE (Xerox Corp., Webster, NY), L. L. KAZMERSKI, K. W. MITCHELL (Solar Energy Research Institute, Golden, CO), R. REIFENBERGER (Purdue University, West Lafayette, IN), and R. F. WOOD (Oak Ridge National Laboratory, Oak Ridge, TN) (U.S. Department of Energy, Workshop on Basic Research Needs and Opportunities on Interfaces in Solar Materials, Denver, CO, June 30-July 3, 1980.) Materials Science and Engineering, vol. 53, Apr. 1982, p. 93-102. refs

The generic problems associated with solar materials solid-solid (S-S) interfaces are reviewed, and goals and techniques for ameliorating the deficiencies are outlined. Photovoltaic, photothermal, and photochemical devices considered are flat plate collectors, thin film Si cells, concentrator systems and compound cells, and polycrystalline systems. Exposure to thermal stresses, electric and radiation fields, chemicals and abrasives during the lifetime of solar cells is expected to create electric, optical, and thermal property changes in the material. Diffusion may also occur in S-S interfacial areas, and determination of the effects on the cells can presently be done using electron microscopy for examining the fine structure, diffraction pattern analysis for the interface structure, and scanning transmission electron microscopy to trace the chemical composition. Additional studies are needed to define the atomic and chemical exchange rates to establish the economic feasibility of low cost cells. M.S.K.

#### A82-35510

##### BASIC RESEARCH NEEDS AND OPPORTUNITIES AT THE SOLID-LIQUID INTERFACE

F. A. CAFASSO (Argonne National Laboratory, Argonne, IL), J. O. BOCKRIS (Texas A & M University, College Station, TX), S. G. DAVISON (Texas, University, Richardson, TX), T. E. FURTAK (Rensselaer Polytechnic Institute, Troy, NY), L. A. HELDT (Michigan Technological University, Houghton, MI), M. L. KNOTEK (Sandia National Laboratory, Albuquerque, NM), J. J. TRUHAN (California, University, Livermore, CA), J. R. WEEKS (Brookhaven National Laboratory, Upton, NY), and L. J. WITTENBERG (Monsanto Research Corp., Miamisburg, OH) (U.S. Department of Energy, Workshop on Basic Research Needs and Opportunities on Interfaces in Solar Materials, Denver, CO, June 30-July 3, 1980.) Materials Science and Engineering, vol. 53, Apr. 1982, p. 103-112. refs

Solid-liquid (S-L) interactions in photoelectrochemical and photoelectrosynthetic devices, the causes and forces of degradation, and the means to study the phenomena are reviewed. Improvements are asserted to be necessary in theoretical modeling, particularly in the fields of double layer theory and kinetic electrochemistry. It is suggested that the electrolyte be treated as a lattice gas, and that the theory of liquid mixtures be employed to find a pair correlation function on which an electronic theory of the electrolyte can be based. Research is recommended to concentrate on modified electrode materials and surfaces, thin film electrodes, and photo-assisted synthesis and electrocatalysis. Specific phenomena to be examined are discussed. M.S.K.

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**A82-35511**

### **BASIC RESEARCH NEEDS AND OPPORTUNITIES AT THE SOLID-GAS INTERFACE**

M. B. BRODSKY (Argonne National Laboratory, Argonne, IL), J. V. CATHCART (Oak Ridge National Laboratory, Oak Ridge, TN), R. S. HANSEN, K. L. KIEWER (U.S. Department of Energy, Ames Laboratory, Ames, IA), U. LANDMAN (Georgia Institute of Technology, Atlanta, GA), R. L. PARK (Maryland, University, College Park, MD), and S. R. SHATYNSKI (Rensselaer Polytechnic Institute, Troy, NY) (U.S. Department of Energy, Workshop on Basic Research Needs and Opportunities on Interfaces in Solar Materials, Denver, CO, June 30-July 3, 1980.) Materials Science and Engineering, vol. 53, Apr. 1982, p. 113-124. refs

Solar energy conversion technologies which involve a solid-gas (S-G) interface in formation or operation and the means to study the related phenomena are reviewed, including thermoelectric and thermionic conversion. The analyses are considered as necessary for characterizing glasses, mirrors, heat mirrors, and transmitters using thermo- and photochromic modeling. Research is indicated on the glass-air interface, the air-solid interface encountered by antireflective coatings, the kinetics, and mechanisms of polymer degradation, and the development of new reflective materials. Absorber materials are explored, along with alternatives such as textured surfaces. Processes of formation, protection, and degradation of solar cells, particularly low cost thin-film devices, are explored, along with junction reaction and decomposition studies of thermoelectric devices and reactions of alkali metal vapors with thermionic devices. M.S.K.

**A82-35513**

### **BASIC RESEARCH NEEDS AND OPPORTUNITIES IN THIN FILMS AND COATINGS**

J. R. ARTHUR (Perkin-Elmer Corp., Physical Electronics Div., Eden Prairie, MN), R. F. BUNSHAH (California, University, Los Angeles, CA), P. J. CALL (Solar Energy Research Institute, Golden, CO), J. E. GREENE (Illinois, University, Urbana, IL), M. G. LAGALLY (Wisconsin, University, Madison, WI), D. M. MATTOX, P. S. PEERCY (Sandia National Laboratory, Albuquerque, NM), J. OGALLAGHER (Chicago, University, Chicago, IL), W. T. PAWLEWICZ (Battelle Pacific Northwest Laboratories, Richland, WA), B. O. SERAPHIN (Arizona, University, Tucson, AZ) et al. (U.S. Department of Energy, Workshop on Basic Research Needs and Opportunities on Interfaces in Solar Materials, Denver, CO, June 30-July 3, 1980.) Materials Science and Engineering, vol. 53, Apr. 1982, p. 137-148.

The effects of basic research into the processing techniques for thin film solar cells on the costs and operating life of the finished product are considered. The use of reflection high energy electron diffraction, low energy electron diffraction, extended X ray fine structure diffraction, and field ion microscopy, along with IR or Raman scattering to examine the structural, chemical, and optical or electronic properties of single crystal and polycrystalline solar cells are explored. Research on vapor deposition rates and molecular beam epitaxy is recommended to be directed toward improving process control. Additional attention is given to physical vapor and chemical vapor deposition processes and the role of in situ measurements. Finally, studies in mechanical, atomic, chemical, and thermal degradation mechanisms are indicated. M.S.K.

**A82-35514**

### **BASIC RESEARCH NEEDS AND OPPORTUNITIES FOR CHARACTERIZING THE MICROSTRUCTURE AND MICROCHEMISTRY OF INTERFACES**

J. SILCOX (Cornell University, Ithaca, NY), P. H. HOLLOWAY (Florida, University, Gainesville, FL), K. R. LAWLESS (Virginia, University, Charlottesville, VA), D. LICHTMAN (Wisconsin, University, Milwaukee, WI), R. G. MEISENHEIMER (California, University, Livermore, CA), L. E. MURR (Oregon Graduate Center,

Beaverton, OR), and C. J. POWELL (National Bureau of Standards, Surface Science Div., Washington, DC) (U.S. Department of Energy, Workshop on Basic Research Needs and Opportunities on Interfaces in Solar Materials, Denver, CO, June 30-July 3, 1980.) Materials Science and Engineering, vol. 53, Apr. 1982, p. 149-162. refs

Research areas for modeling the microcharacteristics of the solid-solid (S-S), solid-liquid (S-L), and solid-gas (S-G) interfaces formed in the fabrication and operation of solar energy conversion devices are identified, along with appropriate methods and instrumentation. Analytical electron microscopy offers the possibility of adequately defining surface topography at materials interfaces. Other techniques for characterizing the behavior of solar materials under changing environmental conditions and over longer periods of time are outlined, noting the necessity of in situ studies to enhance the ability to predict device stability over a thirty-year lifetime. Analyses are described for solar mirrors, absorbers, and photovoltaics, with distinction being made between degradation mechanisms inherent in fabricating the systems and during operation. M.S.K.

**A82-35608#**

### **MILITARY IMPLICATIONS OF A SATELLITE POWER SYSTEM**

J. P. VAJK (Science Applications, Inc., Pleasanton, CA), R. D. STUTZKE (Science Applications, Inc., Colorado Springs, CO), R. SALKELD, G. W. DRIGGERS, and G. H. STINE In: Space manufacturing 4; Proceedings of the Fifth Conference, Princeton, NJ, May 18-21, 1981. New York, American Institute of Aeronautics and Astronautics, 1981, p. 77-87. Research supported by the U.S. Department of Energy. refs

If a satellite power system (SPS), such as is described in the NASA Reference Design Report, were to be undertaken to provide significant quantities of power to the United States and perhaps to other countries as well, significant military implications would ensue. These would arise, first, from the possible uses of such satellites and supporting systems as weapons or as supportive elements of other military systems, and, second, from the necessity of ensuring the security of such important economic assets in space. This paper summarizes some of the highlights of an extensive assessment of the military threats posed by SPS, the vulnerabilities of the Reference Design SPS, and potential safeguards against these threats and vulnerabilities. It is found that no threat issues have been revealed which cannot be mitigated by a judicious combination of safeguards. B.J.

**A82-35637#**

### **POWDER METALLURGY IN SPACE MANUFACTURING**

D. R. CRISWELL In: Space manufacturing 4; Proceedings of the Fifth Conference, Princeton, NJ, May 18-21, 1981. New York, American Institute of Aeronautics and Astronautics, 1981, p. 389-398. refs

Manufacturing processes adaptable for use in space and processes suggested specifically for space production are reviewed with emphasis on the use of powder metallurgy techniques. The key physical processes of powder metallurgy, i.e., powder atomization, hot sintering, and cold welding, are discussed, and a minimum set of production tools (starting kit) which utilizes powdered materials technology is proposed. The starting kit uses solar energy and common lunar materials to produce a wide range of higher order tools of production and products. Two approaches to the production of parts from the powder are examined: the impact molder concept and metal and ceramic clay approach with the use of recoverable binder. V.L.

**A82-35716  
EVIDENCE FOR HOT-ELECTRON INJECTION ACROSS  
P-GAP/ELECTROLYTE JUNCTIONS**

J. A. TURNER and A. J. NOZIK (Solar Energy Research Institute, Golden, CO) Applied Physics Letters, vol. 41, July 1, 1982, p. 101-103. refs  
(Contract EG-77-C-01-4042)

Evidence has been obtained for hot-electron injection from illuminated p-GaP photocathodes into nonaqueous electrolyte containing anthracene as the electron acceptor. The position of the conduction-band edge at the electrolyte interface has been unequivocally established from Mott-Schottky plots in the dark and under illumination; no band-edge movement occurs during the experiment. The observed supraband-edge reduction of anthracene occurs with a hot-electron energy of 0.9 eV. (Author)

**A82-35816  
THEORY OF PHOTOCURRENT IN  
SEMICONDUCTOR-ELECTROLYTE JUNCTION SOLAR CELLS**

F. EL GUIBALY and K. COLBOW (Simon Fraser University, Vancouver, Canada) Journal of Applied Physics, vol. 53, Mar. 1982, p. 1737-1740. refs

Expressions are derived for the current-voltage characteristics of semiconductor-electrolyte junctions. Charge transfer kinetics, surface recombination, recombination in the quasi-neutral region and in the depletion region as well as the effect of the incident illumination on the minority carrier distribution in the semiconductor are included in the model. It is shown that surface transfer velocity for minority carriers is a very important parameter that determines the photocurrent of the cell. The dependence of the photoresponse on the light intensity is shown to be a diagnostic tool in determining the efficiency of charge transfer at the surface. (Author)

**A82-35886  
HOLOGRAPHY CREATES NEW BREED OF OPTICAL  
COMPONENTS**

H. BRODY High Technology, vol. 2, July-Aug. 1982, p. 68-73.

Applications of holographic optical elements are discussed. The construction and reconstruction of surface relief and volume holograms is explained along with the advantages and drawbacks of each. The most important military use of holograms is for improved head-up displays that would not obstruct the pilot's view of the real world and would have a larger field of view than present displays. Another promising field for holograms is scanning lasers, where a rotating disk covered with holograms efficiently substitutes for a spinning multifaceted mirror. Such scanning systems are being used in point-of-sale checkout systems and in text printers. Other promising hologram uses include efficient solar trackers for solar energy production, holographic 'window shades' for energy conservation, and the carrying of light beams of different wavelength on a single optical fiber. C.D.

**A82-35918  
CALCULATING THE SOLAR CONTRIBUTION TO SOLAR  
ASSISTED SYSTEMS**

J. P. GEROFI, E. MANNIK, and G. G. FENTON (Sydney, University, Sydney, Australia) Solar Energy, vol. 28, no. 5, 1982, p. 377-383. refs

After summarizing the methods for calculating the solar contribution for systems without thermal storage, this paper extends a previously proposed method which is based on using a frequency distribution of insolation data. This extension allows rapid hand calculation of solar contribution for most collector types and for any specified collector inlet and outlet temperatures. Typical results are shown to be accurate to within 1 per cent relative to dynamic computer simulation methods. The effect on the method of collector orientation and tilt is discussed, and a simple method of determining the maximum possible (i.e., infinite collector area) solar contribution for a given collector system is described. (Author)

**A82-35920  
SOLAR ENERGY CONVERSION AND STORAGE THROUGH  
SYNTHETIC LIGHT-DRIVEN PROTON PUMPS**

G. W. MURPHY, M. F. LEMONS, and M. M. SPRINGER (Oklahoma, University, Norman, OK) Solar Energy, vol. 28, no. 5, 1982, p. 403-406. NSF-supported research.

Two approaches to the conversion and storage of solar energy through synthetic light-driven proton pumps are discussed and experimental data on model systems are presented. The more promising of these is photoelectrodialytic acid-base production from salt in the charge half cycle and reversible recombination of acid and base to yield electric power in the discharge half cycle. The second method continues previous studies on photochemically induced pH changes in thionine-metal ion systems with improved, though not yet practical, results. (Author)

**A82-35921  
PERFORMANCE TEST OF SOLAR COLLECTOR WITH  
INTERMITTENT OUTPUT**

B. J. HUANG and J. H. LU (National Taiwan University, Taipei, Republic of China) Solar Energy, vol. 28, no. 5, 1982, p. 413-420. National Science Council of the Republic of China refs  
(Contract NSC-69E-0401-02(04))

A solar flat plate collector system which employs a solenoidal valve installed at the exit of the collector to control the hot-water flow is described. A sensor in the solenoid detects a sufficient temperature in the water and orders the valve opened. Inflowing colder water causes the valve to reshut, thus maintaining hot water in the system loop. The energy balance of the system was modeled numerically and a collector outfitted with the solenoid switch was tested in conjunction within a storage tank application. Measurements were made with varying collector tilts, the outflow mass for each cycle, the average efficiency, and the intermittent period output. Good qualitative correlations were observed between the predicted and measured performance of the system. M.S.K.

**A82-35922  
THE RATES OF SOLAR ENERGY STORAGE AND RETRIEVAL  
IN A ZEOLITE-WATER SYSTEM**

R. GOPAL, B. R. HOLLEBONE, C. H. LANGFORD, and R. A. SHIGEISHI (Carleton University, Ottawa, Canada) Solar Energy, vol. 28, no. 5, 1982, p. 421-424. Department of Supply and Services  
(Contract DSS-07SU-3115-9-2682)

The salient features that determine the possible use of a water vapour-zeolite 13X system as a method of energy storage were investigated. Cycling studies over two months revealed no decrease in water capacity nor any structural deterioration. The rate at which water could be desorbed in a static situation was determined at various temperatures from 110 to 250 C. The adsorption isotherm and the heats of adsorption as a function of amount of adsorbed water were determined. The saturation capacity was 0.33 g H<sub>2</sub>O/g zeolite while the heat of adsorption declined from 90 to 50 kJ kJ/mol. The rate of heat development was found to be very high so that heat extraction from the store would not be a problem in any practical utilization of this system. (Author)

**A82-36117  
TWO-ELEMENT CASCADE AL-GA-AS SOLAR CELL**

ZH. I. ALFEROV, V. M. ANDREEV, N. S. ZIMOGOROVA, O. O. IVENTEVA, and V. I. MYRZIN (Pis'ma v Zhurnal Tekhnicheskoi Fiziki, vol. 7, July 26, 1981, p. 833-836.) Soviet Technical Physics Letters, vol. 7, July 1981, p. 357, 358. Translation. refs

Monolithic cascade solar cells in which each cell is used as an independent power supply have been fabricated by liquid-phase epitaxy on GaAs substrates in the (100) orientation. The monolithic cascade solar cells consist of two photocells: (1) the upper cell with a p-n junction in Al(y)Ga(1-y)As and a protective window of Al(x)Ga(1-x)As, where x is 0.9 or more and (2) the lower cell with a p-n junction in gallium arsenide, for which an Al(y)Ga(1-y)As solid solution serves as a window. The efficiency of a monolithic cascade structure with a gap width of 1.65 eV, fabricated in a

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single technological process, is 18%, i.e. twice the efficiency reported previously for a GaAs-AlAs cascade cell. V.L.

### A82-36163

#### GERMANIUM SELECTIVE SOLAR ABSORBER SURFACES

P. P. THOGERSEN, F. H. COCKS, P. L. JONES (Duke University, Durham, NC), and J. T. A. POLLOCK *Journal of Materials Science*, vol. 17, May 1982, p. 1377-1380. refs

Thin Ge films, produced by evaporation through 0.3, 1 and 3 torr pressures of argon onto polished aluminum substrates were found to exhibit selective absorption behavior. Maximum absorptance to emittance ratios of 13:1 were measured, with values of 8:1 for films having solar absorptances of 0.9. Film structures were significant in determining collection efficiency. Films deposited at 0.3 torr showed better overall properties due to a larger particle size of about 1 micron compared with an approximate 0.1 micron size measured with films deposited at 1 and 3 torr. (Author)

### A82-36208

#### HEAT LOSS FACTOR FOR LINEAR SOLAR CONCENTRATORS

S. C. MULLICK and S. K. NANDA (Indian Institute of Technology, New Delhi, India) *Applied Energy*, vol. 11, May 1982, p. 1-13. refs

Numerical techniques are developed for calculating the heat loss factor through the glass cover of a cylindrical solar concentrator. The configuration considered was a steel tube suspended in the central space of a concentric glass tube. Heat transfer coefficients were determined for both the radiative heat between the tube and the glass and the convective heat transfer within the medium between the steel and the glass. The sum of the two coefficients is treated as the total heat transferred to the outside air by forced or mixed convection. Correlations of the outside to inside heat transfer resistances ratio to the wind velocity, the absorber temperature, the emittance of black paint, etc. were formulated. The results are noted to be applicable to flat plate collectors and useful for manufacturers of solar equipment. M.S.K.

### A82-36210

#### CHEMICALLY SPRAYED PBS COATINGS FOR PHOTOTHERMAL SOLAR ENERGY CONVERSION: R. C. AGARWAL AND P. K. C. PILLAI (INDIAN INSTITUTE OF TECHNOLOGY, NEW DELHI, INDIA)

*Applied Energy*, vol. 11, May 1982, p. 61-68. refs

This paper reports on an investigation into the optical and physical properties of PbS coatings prepared by spray pyrolysis onto chemically brightened aluminum substrates. The advantages are low cost, reasonably good selectivity and the coatings' ability to be scaled onto collectors of any desired size. The coatings exhibit a high absorptivity in the solar range and a low emissivity in the thermal range. Finally, the photothermal conversion efficiencies of black paint-coated and PbS-coated solar collectors are compared. (Author)

### A82-36215

#### ZAP - INTRODUCING THE ZERO-BIAS AVALANCHE PHOTODIODE

T. P. PEARSALL (Bell Telephone Laboratories, Inc., Murray Hill, NJ) *Electronics Letters*, vol. 18, June 10, 1982, p. 512-514. refs

A novel heterostructure p-n junction diode is described which provides a photocurrent gain of 2 under zero external bias conditions. The necessary energy required to produce the additional electron-hole pair would be supplied by the internal electric field associated with the heterojunction energy gap difference. The ZAP diode structure has energy conversion applications as a photovoltaic detector whose efficiency may be enhanced by as much as 25% over that obtainable using homojunction solar cells. The device has, however, yet to be built. (Author)

### A82-36227

#### AS-DEPOSITED CVD AMORPHOUS SILICON FILMS FOR SOLAR PHOTOVOLTAIC APPLICATIONS

S. V. KOINOV, L. V. VASILEV, L. K. MLADZHOV, and S. K. KANEV (Bulgarian Academy of Sciences, Solar Energy and New Energy Sources Laboratory, Sofia, Bulgaria) *Bolgarskaia Akademiia Nauk, Doklady*, vol. 35, no. 2, 1982, p. 161-164. refs

Amorphous silicon films were deposited by the pyrolytic decomposition of silane at atmospheric pressure. They exhibited conductive and photoconductive properties similar to those inherent to glow-discharge amorphous Si:H alloys and sputtered in Ar-H plasma. A model of the possible hydrogenation of the material is presented. (Author)

### A82-36283\*

Jet Propulsion Lab., California Inst. of Tech., Pasadena.

#### FRACTURE OF DIRECTIONALLY SOLIDIFIED MULTICRYSTALLINE SILICON

C. P. CHEN, M. H. LEIPOLD, JR. (California Institute of Technology, Jet Propulsion Laboratory, Pasadena, CA), and D. HELMREICH (Heliotronic GmbH, Burghausen, West Germany) *American Ceramic Society, Journal*, vol. 65, Apr. 1982, p. C-49. Research supported by the U.S. Department of Energy; Bundesministerium fuer Forschung und Technologie refs (Contract BMFT-NT-0845/0846)

Fracture toughness data is given for multicrystalline silicon which has been prepared by directional solidification. Results indicated a plane-strain fracture toughness of 0.8 to 0.87 MN/m to the 3/2 power, which is consistent with data for single-crystal silicon. (Author)

### A82-36750

#### THERMAL AND PHOTOCHEMICAL STUDIES OF SOLAR ENERGY ABSORBERS DISSOLVED IN HEAT TRANSFER FLUIDS

A. R. BURKE, D. E. ETTER, C. R. HUDGENS, C. J. WIEDENHEFT, and L. J. WITTENBERG (Monsanto Research Corp., Miamisburg, OH) *Solar Energy Materials*, vol. 6, May-June 1982, p. 481-490. refs

(Contract DE-AC04-76DP-00053)

Thermal stability, photochemical stability and optical absorptivity at elevated temperatures of various heat transfer fluids containing chromophoric materials were studied. Eight chromo

### A82-36863

#### SPRAY-DEPOSITED SnO<sub>2</sub>/N-Si/POLYCRYSTALLINE/ SOLAR CELLS

A. BHARDWAJ, K. S. KALONIA, A. RAZA, A. K. SHARMA, B. K. GUPTA, and O. P. AGNIHOTRI (Indian Institute of Technology, New Delhi, India) *Solar Cells*, vol. 5, Apr. 1982, p. 305-311. Research supported by the Ministry of Industrial Development of India. refs

In response to recent interest in the development of semiconductor-insulator-semiconductor solar cells, which obviate high temperature processing, SnO<sub>2</sub>/n-Si solar cells were fabricated by the spray deposition of SnO<sub>2</sub> onto n-type polycrystalline silicon of 0.1-1 ohm cm resistivity. The thickness of the chemically grown interface layer is estimated to be 18 Å, and capacitance-voltage measurements indicate a barrier height of 0.68 V. The performance parameters of this heterojunction solar cell include: (1) an 0.452 V open circuit voltage; (2) a 19.7 mA/sq cm current density; (3) an 0.634 fill factor; and (4) a conversion efficiency of 7.06% at an illumination of 80 mW/sq cm. O.C.

### A82-36864

#### CZOCHELSKI SILICON SOLAR CELL MODULES - PRESENT COST AND FUTURE PROSPECTS

R. M. MOORE (Solar Energy Research Institute, Golden, CO; Chevron Research Corp., Solar Div., Richmond, CA) *Solar Cells*, vol. 5, Apr. 1982, p. 313-329. refs

A multipath learning curve model of the development of the Czochralski process silicon solar cell industry is first tested through application of historical data for the 1974-1979 period, and upon

confirmation of its ability to predict price dynamics is used to forecast production costs in 1980-1985. The 1985 forecasts, in 1979 U.S. dollars, are \$2.2/peak W at 10% estimated confidence level, \$3.1-3.2/peak W at 50% estimated confidence level and \$4.8/peak W at 90% estimated confidence level. It is concluded in light of these estimates that the 1985 state of development of the Czochralski silicon solar cell industry does not represent an attractive investment for major companies presently involved in related work, while a very attractive market is presented for small companies which are already participating in production. The resource base of small companies, however, is insufficient to support the investment levels required in 1980-1985. A primary consequence of this research is that the choice of the wafer or ribbon form of silicon crystal material chosen for intensive development is less important than the research and development emphasis which must be placed on the reduction of high purity polycrystalline silicon feedstock costs. O.C.

#### **A82-36865 CONDUCTOR-INSULATOR-SEMICONDUCTOR ORGANIC SOLAR CELLS**

R. O. LOUTFY, Y.-H. SHING, and D. K. MURTI (Xerox Research Centre of Canada, Mississauga, Ontario, Canada) Solar Cells, vol. 5, Apr. 1982, p. 331-341. refs

A new class of conductor-insulator-semiconductor (CIS) organic solar cells has been developed, whose novel features include the application of a transparent, conductive front electrode and a thin insulating layer. The selection of the front electrode divides CIS organic cells into three configurations: (1) a metal-insulator-semiconductor cell having a metal front electrode; (2) a semiconductor-insulator-semiconductor cell having a degenerate semiconductor electrode; and (3) an electrolyte-insulator-semiconductor cell using electrolytic contact. The barrier formation in the base organic semiconductor is determined by the work function of the transparent conductive electrode. The material used in the present study for the base semiconducting layer is an X-phase, metal-free phthalocyanine-polymer binder combination which can be deposited onto a substrate by solution casting. O.C.

#### **A82-36867 EFFECTIVE DRIFT CURRENT DENSITIES IN THE N-TYPE HEAVILY DOPED EMITTER REGION OF P-N/PLUS/ JUNCTION SILICON SOLAR CELLS**

H. V. CONG and S. BRUNET (Perpignan, Universite, Perpignan, France) Solar Cells, vol. 5, Apr. 1982, p. 355-365. refs

#### **A82-36868 ANALYTICAL EXPRESSIONS FOR THE DETERMINATION OF THE MAXIMUM POWER POINT AND THE FILL FACTOR OF A SOLAR CELL**

G. L. ARAUJO and E. SANCHEZ (Escuela Tecnica Superior de Ingenieros de Telecomunicacion, Madrid, Spain) Solar Cells, vol. 5, Apr. 1982, p. 377-386. Research supported by the Ministry of Industry and Energy. refs

#### **A82-36869 A COMMENT ON THE GENERALIZATION OF THE THEORETICAL BASIS OF PHOTOVOLTAIC CONCENTRATORS FOR EXTENDED LIGHT SOURCES**

A. LUQUE (Escuela Tecnica Superior de Ingenieros de Telecomunicacion, Madrid, Spain) Solar Cells, vol. 5, Apr. 1982, p. 387-389.

Maximum optical concentration is achieved by a solar cell collector when it is illuminated isotropically, with the concentrator oriented in such a way that solar source area,  $A(s)$ -prime, equals the area of highest energy collection,  $A(s)$ . It is shown that the  $A(s)$ -prime/ $A(s)$  orientation factor permits the application of the theory proposed by Luque (1981) to concentrators which are not optimally oriented, such as asymmetric concentrators, with emphasis on errors that could arise from not using the orientation factor. O.C.

#### **A82-37116# DEVELOPMENT EFFORT OF SHEET MOLDING COMPOUND /SMC/ PARABOLIC TROUGH PANELS**

P. A. KIRSCH (Budd Co., Ft. Washington, PA) and R. L. CHAMPION (Sandia National Laboratory, Albuquerque, NM) In: Reinforced Plastics/Composites Institute, Annual Conference, 36th, Washington, DC, February 16-20, 1981, Preprints. New York, Society of the Plastics Industry, Inc., 1981 (Session 26-C). 4 p. Research supported by Sandia National Laboratory.

Technical considerations at efforts to develop parabolic solar reflectors using sheet molding compounds with glass reflectors molded into the troughs are described. Strengthening of mirrored glass sheets followed by application of an adhesive was found to provide good protection for both the silvered back of the mirror and the sheet molding compound after the two were joined in a single press stroke of a compression molding process. Details of the prototype one meter wide troughs with a 19.01 in. focal length are provided, including design solutions such as three external ribs joined to two external coaming ribs to provide the required stiffness. Changes in the size of the sheet molding after curing and in cooling to room temperature were accounted for by modeling with an appropriate standard deviation, and fabricating the trough panel mold to a smaller focal length, 18.95 in. Prospects for transferring the techniques to mass production are considered favorable. M.S.K.

#### **A82-37438 DESIGN OF A SYSTEM FOR SOLAR ENERGY STORAGE VIA WATER ELECTROLYSIS**

A. KOUKOUVINOS, V. LYGEROU, and N. KOUMOUTSOS (Athens, National Technical University, Athens, Greece) International Journal of Hydrogen Energy, vol. 7, no. 8, 1982, p. 645-650. refs

The design and economic evaluation of a system that provides electricity for an average one-family dwelling by utilizing solar energy are detailed. Solar energy is converted by photovoltaic arrays to electricity which is then used for the electrolysis of water. The hydrogen produced is stored in the form of hydride and can be used either for direct burning, to meet the thermal energy requirements, or in a fuel cell to supply the electric energy needed. Particular emphasis was given to designing a control system that could guarantee a smooth intermittent operation of the electrolytic unit and the utilization of the maximum output of the photovoltaic cells. The system selected can operate with minimum attendance and very little maintenance. The cost of the electricity produced is as high as \$3.30/kWh. (Author)

#### **A82-37588 DETERMINATION OF THE STAGNATION TEMPERATURE OF FLAT PLATE SOLAR COLLECTORS [BESTIMMUNG DER STILLSTANDTEMPERATUR VON FLACHKOLLEKTOREN]**

K. MASSMEYER (Kernforschungsanlage Juelich GmbH, Institut fuer Kernphysik, Juelich; Koeln, Universitaet, Cologne, West Germany), J. W. GRUETER, H. D. TALAREK (Kernforschungsanlage Juelich GmbH, Institut fuer Kernphysik, Juelich, West Germany), and E. RASCHKE (Koeln, Universitaet, Cologne, West Germany) Meteorologische Rundschau, vol. 35, June 1982, p. 67-75. In German. refs

For the safe operation of collector systems, it is necessary to determine the highest temperature which can occur in the collector for conditions under which no energy is withdrawn from the collector. A description is presented of a method which makes it possible to determine this temperature. The considered method does not depend on the meteorological conditions, and provides also values regarding the temperature dependence of the heat transmission coefficient of flat plate collectors. Global insolation is found to have the greatest effect on the stagnation temperature. Fluctuations in wind velocity between 0 and 5 m/s produce approximately the same variations in stagnation temperature as changes of the environmental temperature from -10 C to +40 C. The contribution provided by diffuse insolation is nearly one order of magnitude less. G.R.

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**A82-37629**

**TERNARY CHALCOGENIDE-BASED PHOTOELECTROCHEMICAL CELLS. II - THE N-CDIN<sub>2</sub>SE<sub>4</sub>/AQUEOUS POLYSULFIDE SYSTEM**

R. TENNE, Y. MIROVSKY, Y. GREENSTEIN, and D. CAHEN (Weizmann Institute of Science, Rehovot, Israel) *Electrochemical Society, Journal*, vol. 129, July 1982, p. 1506-1512. Research supported by the U.S.-Israel Binational Science Foundation. refs

The behavior of CdIn<sub>2</sub>Se<sub>4</sub>, a ternary analog of CdSe, as a photoanode in an aqueous polysulfide photoelectrochemical cell is investigated. Measurements of I-V curves in the dark and under illumination show that potentiostatic photoetching under large reverse bias leads to a dramatic increase in cell photocurrent (up to about 15 mA/sq cm under reverse bias of 400 mV) and a decrease in the dark currents under reverse bias as well as an improvement in output stability. Spectral response measurements reveal a considerable subbandgap photocurrent for the etched electrode, most of which disappears after photoetching, accompanied by an order of magnitude increase in the response to supra-bandgap excitation. Analysis of the shape of the spectral response reveals two distinct transition modes: an indirect transition at 1.55 eV and a direct transition at 1.72 eV. Finally, preliminary tests on thin film polycrystalline electrodes demonstrate an encouraging performance for polycrystalline material. A.L.W.

**A82-37633**

**THE ROLE OF BE IN /GAAL/AS/GAAS SOLAR CELLS**

K. MASU, S.-I. NAKATSUKA, M. KONAGAI, and K. TAKAHASHI (Tokyo Institute of Technology, Tokyo, Japan) *Electrochemical Society, Journal*, vol. 129, July 1982, p. 1623-1627. refs

The diffusion and doping behavior of Be in (GaAl)As/GaAs solar cells are investigated. Be diffusion into n-GaAs was followed during the LPE growth of Be-doped Ga(0.2)Al(0.8)As layers on the n-GaAs substrate at initial growth temperatures of 700 to 900 °C, cooling rates from 0 to 0.5 °C/min, growth durations of 10 to 120 min, and dopant concentrations from 0.01 to 0.3 at. %. The thickness of the Be-diffused p-GaAs region is found to increase with increasing growth temperature, leading to an exponential form for the dependence of the diffusion coefficient on temperature. The diffusion coefficient is also found to be proportional to the beryllium concentration in the growth melt. Measurements demonstrate the resistivity of Be-doped p-Ga(0.2)Al(0.8)As to be about 10 times higher than that of Be-diffused p-GaAs, with an acceptor energy level for Be in Ga(0.2)Al(0.8)As of 47 meV. An electron diffusion length of 4.3 microns was measured in p-GaAs at an average free-carrier concentration of about 10 to the 18th/cu cm. Finally, measurements of the photovoltaic characteristics of beryllium-doped (GaAl)As/GaAs p-p-n solar cells reveal a conversion efficiency in excess of 20% (AM1) and a peak output power of about 5 W/sq cm at 400 suns. A.L.W.

**A82-37634**

**P-TYPE AMORPHOUS SILICON/LIQUID JUNCTION SOLAR CELL**

W. M. AYERS (Exxon Research and Engineering Co., Linden, NJ) *Electrochemical Society, Journal*, vol. 129, July 1982, p. 1644-1646.

The characteristics of p-type amorphous silicon, a low-cost material under consideration for use for the photoelectrodes of a liquid junction solar cell, and of such a cell based on this material, are investigated. Measurements of the decrease in cell photovoltage as the aqueous vanadium electrolyte drifts to more oxidizing potentials indicate that although surface states are present, they do not act to pin the Fermi level of p-type amorphous silicon. Experiments demonstrate an open circuit voltage of 0.41 V, short circuit current of 0.18 mA/sq cm and fill factor of 0.3 when the electrolyte potential is driven to -0.51 V (vs SCE). An efficiency of 0.06% is obtained at 40 mW/sq cm illumination. The cell was also able to sustain a 1.3 microamp/sq cm current density for over an hour with no indication of failure, demonstrating the stability of the electrode. p-type amorphous silicon is thus concluded to be a promising material for thin-film photocathodes, with its major limitation the low short-circuit current. A.L.W.

**A82-37671**

**PHYSICAL BASIS OF POWER CONVERSION OF ENERGY FLUCTUATIONS**

J. C. YATER *Physical Review A - General Physics*, 3rd Series, vol. 26, July 1982, p. 522-538. refs

The power conversion of energy fluctuations is an alternate energy source with the potential, in principle, to achieve the maximum efficiency of the Carnot cycle. An analysis is conducted concerning the physical basis for the design of circuits to implement the considered approach. The reversible-energy-fluctuations (REF) converter first absorbs and converts thermal energy incoming by conduction, convection, or radiation into electric energy fluctuations in a first layer. The energy-transducing first layer and a thermal-barrier second layer provide a physical basis to achieve various goals for the power conversion of the energy fluctuations transferred to the diodes in a third layer. The goals include an efficiency approaching the Carnot limit for reversible operations, a much larger power output than provided in concentrated solar energy, less exacting material requirements, and a very wide temperature range of operation. G.R.

**A82-37850**

**CURRENT-VOLTAGE RESPONSE OF TANDEM JUNCTION SOLAR CELLS**

R. R. POTTER, J. R. SITES (Colorado State University, Fort Collins, CO), and S. WAGNER (Princeton University, Princeton, NJ) *Journal of Applied Physics*, vol. 53, July 1982, p. 5269-5272. refs (Contract XF-1-1237-1)

A tandem cell is modeled and tested against experimental results. A planar structure is considered in which high energy photons are absorbed by an outer semiconductor material. The salient features of a straightforward model in which series resistance and leakage current are considered individually for the constituent cells are shown. The current superposition principle is used by taking the total current of a diode as the algebraic sum of dark and photocurrents, while charge trapping in bulk or interface states is neglected. The model is compared with experimental results from the 'monolithic' n-Si/SnO<sub>2</sub>/n-CdSe/electrolyte cell and with the two individual cells that constitute the tandem structure. Results show that much optimization may be carried out using each diode separately, where thin films are supported on glass substrates. By using the individual J-V curves, obtained when the junctions are stacked in the light beam, one can predict the maximum tandem output. C.D.

**A82-37851**

**PROPERTIES AND STRUCTURE OF A-SiC:H FOR HIGH-EFFICIENCY A-SI SOLAR CELL**

Y. TAWADA, M. KONDO, H. OKAMOTO, Y. HAMAKAWA (Osaka University, Toyonaka, Japan), and K. TSUGE *Journal of Applied Physics*, vol. 53, July 1982, p. 5273-5281. Research supported by the Ministry of Education, Science, and Culture and Agency of Industrial Science and Technology. refs

A series of experimental investigations on optical and optoelectronic properties of methane and ethylene-based a-SiC:H films has been made. The chemical bonding structure of such films has also been explored with IR absorption structural analysis. An experimental verification for the wide gap window material in the amorphous silicon solar cell is shown for methane and ethylene-based a-SiC:H. The methane-based film shows a one or two orders of magnitude larger photoconductivity recovery effect resulting from doping than the ethylene-based one. IR absorption analysis shows that the methane-based a-SiC:H film is recognized as a rather ideal amorphous SiC alloy as compared with the ethylene-based one. It is found that the methane-based film is almost constructed with tetrahedrally coordinated carbons or carbons attached to a hydrogen, and is superior to the ethylene-based one for a window material in a p-i-n solar cell. C.D.

A82-37944

**IONIZED IMPURITY INDUCED PHOTOCARRIER GENERATION IN ORGANIC ENERGY CONVERSION SYSTEMS**

Z. D. POPOVIC (Xerox Research Centre of Canada, Mississauga, Ontario, Canada) Journal of Chemical Physics, vol. 77, July 1, 1982, p. 498-508. refs

The present study has the objective to investigate the influence of the discrete nature of ionized impurities in a Schottky barrier on the field dependent carrier generation of an organic photovoltaic cell. Attention is given to the influence of the local ionized impurity field on the carrier generation, compared to the influence of the average field in the barrier. It is assumed that exciton dissociation into electron-hole pairs can be adequately described as a function of the local electric field. The proposal is made that thermal regeneration of ionized impurities can lead to continuous charge production based on the proposed mechanism. The study has been motivated by a significant discrepancy observed between the measured and calculated carrier generation efficiencies in x-metal-free phthalocyanine photovoltaic cells. The proposed mechanism of ionized impurity-assisted carrier generation offers an explanation for the observed enhancement in x-metal-free phthalocyanine photovoltaic cells. G.R.

A82-37973#

**CENTRAL SOLAR RECEIVERS - APPLICATIONS FOR UTILITIES AND INDUSTRY**

P. A. CURTO (Gibbs and Hill, Inc., Washington, DC) and G. STERN Mechanical Engineering, vol. 104, July 1982, p. 54-57.

Two fundamentally different types of central solar receiver systems - molten salt and forced air systems - have been developed to the point of commercial demonstration. In the molten salt system, molten salt is heated to about 600 C and used to produce steam for power generation. The overall peak efficiency (sunlight to electricity) is approximately 23.2% using the molten salt concept, compared to 8-12% with photovoltaics. In the forced-air system, ambient air is inducted into speed-controlled gas turbines, forced through a metal tube receiver, heated to 600-816 C, and then expanded into several different turbines. The exhaust air can be utilized in various ways, depending on the downstream process conditions. A table of the combined cycle system performances for the forced-air system shows that the overall cycle efficiencies range from 35.6 to 37.4% (from heat to electricity), while when coupled with an annual average (sunlight-to-heat) collection efficiency of 54% in the air receiver, overall annual system efficiency ranges from 19.2 to 20.2%, with peak efficiency as high as 23.2%. Detailed diagrams of each of the two systems are given. The new generation of these plants have broad applications in new and retrofit utility and industrial facilities. The projected costs are competitive, even for first-generation plants. N.B.

N82-22652\*# Jet Propulsion Lab., California Inst. of Tech., Pasadena.

**THE 19TH PROJECT INTEGRATION MEETING Progress Report, Jul. - Nov. 1981**

R. R. MCDONALD Nov. 1981 397 p refs  
(Contract NAS7-100; DE-A101-76ET-20356)

(NASA-CR-168822; JPL-PUB-82-11; DOE/JPL-1012-67; NAS 1.26:168822; PR-19) Avail: NTIS HC A17/MF A01 CSCL 10A

The Flat-Plate Solar Array Project is described. Project analysis and integration is discussed. Technology research in silicon material, large-area silicon sheet and environmental isolation; cell and module formation; engineering sciences, and module performance and failure analysis. It includes a report on, and copies of visual presentations made at, the 19th Project Integration Meeting held at Pasadena, California, on November 11, 1981.

Author

N82-22653\*# Jet Propulsion Lab., California Inst. of Tech., Pasadena.

**SOLAR POND POWER PLANT FEASIBILITY STUDY FOR DAVIS, CALIFORNIA**

Y. C. WU, M. J. SINGER, H. E. MARSH, J. HARRIS, and A. L. WALTON 15 Feb. 1982 73 p refs Prepared for the City of Davis, Calif.

(Contract NAS7-100)

(NASA-CR-168819; JPL-PUB-82-16; JPL-5107-4; NAS

1.26:168819) Avail: NTIS HC A04/MF A01 CSCL 10A

The feasibility of constructing a solar pond power plant at Davis, California was studied. Site visits, weather data compilation, soil and water analyses, conceptual system design and analyses, a material and equipment market survey, conceptual site layout, and a preliminary cost estimate were studied. It was concluded that a solar pond power plant is technically feasible, but economically unattractive. The relatively small scale of the proposed plant and the high cost of importing salt resulted in a disproportionately high capital investment with respect to the annual energy production capacity of the plant. Cycle optimization and increased plant size would increase the economical attractiveness of the proposed concept. R.J.F.

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**SALTON SEA PROJECT, PHASE 1 Final Report**

M. L. PEELGREN 15 Jan. 1982 129 p refs

(Contract NAS7-100; DE-A101-79ET-20307)

(NASA-CR-168804; JPL-PUB-81-108; JPL-1060-54; JPL-5107-2;

NAS 1.26:168804) Avail: NTIS HC A07/MF A01 CSCL 10A

A feasibility study was made for a salt gradient solar pond power plant in or near the Salton Sea of California. The conclusions support continuance 5-MWe proof-of-concept experiment, and ultimate construction by an electric utility company of a 600-MWe plant. The Solar Pond concept would be an environmental benefit to the Salton Sea by reversing the increasing salinity trend. The greatest cost drivers are the lake dike construction and pond sealing. Problems to be resolved include method of brine production from Salton Sea water for the first unit (which requires evaporation pond area and time), the high turbidity and color content of the Salton Sea water (which requires pretreatment), and other questions related to pond permeability, bio-activity and soil/brine chemical reactions. All technical and environmental problems appear solvable and/or manageable if care is taken in mitigating impacts. Author

N82-22656\*# Jet Propulsion Lab., California Inst. of Tech., Pasadena.

**PHOTOVOLTAICS AS A TERRESTRIAL ENERGY SOURCE. VOLUME 2: SYSTEM VALUE**

J. L. SMITH Oct. 1980 41 p refs 3 Vol.

(Contract NAS7-100; DE-A101-79CS-30315)

(NASA-CR-168809; JPL-PUB-81-103-VOL-2; JPL-5220-15; NAS

1.26:168809; DOE/ET-20356/6-VOL-2) Avail: NTIS HC

A03/MF A01 CSCL 10A

Assumptions and techniques employed by the electric utility industry and other electricity planners to make estimates of the future value of photovoltaic (PV) systems interconnected with U.S. electric utilities were examined. Existing estimates of PV value and their interpretation and limitations are discussed. PV value is defined as the marginal private savings accruing to potential PV owners. For utility-owned PV systems, these values are shown to be the after-tax savings in conventional fuel and capacity displaced by the PV output. For non-utility-owned (distributed) systems, the utility's savings in fuel and capacity must first be translated through the electric rate structure (prices) to the potential PV system owner. Base-case estimates of the average value of PV systems to U.S. utilities are presented. The relationship of these results to the PV Program price goals and current energy policy is discussed; the usefulness of PV output quantity goals is also reviewed. M.D.K.

## 02 SOLAR ENERGY

**N82-22657\*#** Jet Propulsion Lab., California Inst. of Tech., Pasadena.

**PHOTOVOLTAICS AS A TERRESTRIAL ENERGY SOURCE. VOLUME 3: AN OVERVIEW**

J. L. SMITH Oct. 1980 41 p refs 3 Vol.

(Contract NAS7-100; DE-AI01-79CS-30315)

(NASA-CR-168810; JPL-PUB-81-103-VOL-3; JPL-5220-15; NAS 1.26:168810; DOE/ET-20356/6-VOL-3) Avail: NTIS HC

A03/MF A01 CSCL 10A

Photovoltaic (PV) systems were evaluated in terms of their potential for terrestrial application. A comprehensive overview of important issues which bear on photovoltaic (PV) systems development is presented. Studies of PV system costs, the societal implications of PV system development, and strategies in PV research and development in relationship to current energy policies are summarized. M.D.K.

**N82-22660\*#** Jet Propulsion Lab., California Inst. of Tech., Pasadena.

**PHOTOVOLTAIC SYSTEMS TEST FACILITIES: EXISTING CAPABILITIES COMPILATION**

K. VOLKMER 1 Mar. 1982 31 p

(Contract NAS7-100; DE-AI01-76ET-20356)

(NASA-CR-168802; JPL-PUB-14-REV-1; JPL-5240-3-REV-A; NAS 1.26:168802; DOE/ET-20456/1-REV-1) Avail: NTIS HC

A03/MF A01 CSCL 10A

A general description of photovoltaic systems test facilities (PV-STFs) operated under the U.S. Department of Energy's photovoltaics program is given. Descriptions of a number of privately operated facilities having test capabilities appropriate to photovoltaic hardware development are given. A summary of specific, representative test capabilities at the system and subsystem level is presented for each listed facility. The range of system and subsystem test capabilities available to serve the needs of both the photovoltaics program and the private sector photovoltaics industry is given. R.J.F.

**N82-22664\*#** Jet Propulsion Lab., California Inst. of Tech., Pasadena.

**REGIONAL APPLICABILITY AND POTENTIAL OF SALT-GRADIENT SOLAR PONDS IN THE UNITED STATES. VOLUME 1: EXECUTIVE SUMMARY**

E. I. H. LIN 1 Mar. 1982 23 p 2 Vol.

(Contract NAS7-100; DE-AI03-81SF-11552)

(NASA-CR-168805; JPL-PUB-82-10-VOL-1; DOE/JPL-1060-50-VOL-1; JPL-5107-1-VOL-1; NAS 1.26:168805)

Avail: NTIS HC A02/MF A01 CSCL 10A

Findings of a survey concerning salt ponds are summarized. The residential, commercial, and institutional buildings sector is discussed. The industrial process heat sector is considered. The agricultural process heat sector is examined. The electrical power sector is reviewed. The desalinization sector is considered. N.W.

**N82-22665\*#** Jet Propulsion Lab., California Inst. of Tech., Pasadena.

**REGIONAL APPLICABILITY AND POTENTIAL OF SALT-GRADIENT SOLAR PONDS IN THE UNITED STATES. VOLUME 2: DETAILED REPORT**

E. I. H. LIN et al. 15 Mar. 1982 500 p refs 2 Vol.

(Contract NAS7-100; DE-AT04-80AL-13135)

(NASA-CR-168806; JPL-PUB-82-10-VOL-2; JPL-5107-1-VOL-2; DOE/JPL-1060-50-VOL-2; NAS 1.26:168806) Avail: NTIS HC

A21/MF A01 CSCL 10A

A comprehensive assessment of the regional applicability and potential of salt-gradient solar ponds in the United States is provided. The assessment is focused on the general characteristics of twelve defined geographic regions. Natural resources essential to solar ponds are surveyed. Meteorological and hydrogeological conditions affecting pond performance are examined. Potentially favorable pond sites are identified. Regional thermal and electrical energy output from solar ponds is calculated. Selected pond design cases are studied. Five major potential market sectors are evaluated in terms of technical and energy-consumption

characteristics, and solar-pond applicability and potential. Relevant pond system data and financial factors are analyzed. Solar-pond energy costs are compared with conventional energy costs. The assessment concludes that, excepting Alaska, ponds are applicable in all regions for at least two market sectors. Total solar pond energy supply potential in the five market sectors examined is estimated to be 8.94 quads/yr by the year 2000, approximately 7.2% of the projected total national energy demand. Author

**N82-22668#** Midwest Research Inst., Golden, Colo.

**THE TRADE-OFF BETWEEN COLLECTOR AREA, STORAGE VOLUME, AND BUILDING CONSERVATION IN ANNUAL STORAGE SOLAR HEATING SYSTEMS**

S. SILLMAN Mar. 1981 123 p refs

(Contract EG-77-C-01-4042)

(SERI/TR-721-907) Avail: NTIS HC A06/MF A01

A comprehensive study based on computer simulation of the performance of active solar heating systems with large storage tanks was made. The investigation focused on systems used to supply backup heat to passive solar and energy-conserving buildings as well as systems designed to meet standard heating loads. Results show that system performance increases linearly as storage volume is increased, up to the point where the storage tank is large enough to store all heat collected in summer. The optimal design for annual storage systems is discussed and a contrast with diurnal storage systems is made. It is suggested that the annual storage systems may be economically preferable to the diurnal systems. M.D.K.

**N82-22670#** Midwest Research Inst., Golden, Colo. Solar Energy Research Inst.

**THE TRADE-OFF BETWEEN COLLECTOR AREA, STORAGE VOLUME AND BUILDING CONSERVATION IN ANNUAL STORAGE SOLAR HEATING SYSTEMS**

S. SILLMAN Apr. 1981 6 p refs Presented at AS/ISES Conf. and Exposition, Philadelphia, 26-30 May 1981

(Contract EG-77-C-01-4042)

(SERI/TR-721-907) Avail: NTIS HC A02/MF A01

A comprehensive computer simulation of the performance of active solar heating systems with long term hot water storage. Systems used to supply backup heat to passive solar and energy conserving buildings, as well as to meet standard heating and hot water loads were investigated. It is shown that system output increases linearly as storage volume increases, up to the point where the storage tank is large enough to store all heat collected in summer. This point, the point of unconstrained operation, is the likely economic optimum. Unlike diurnal storage systems, annual storage systems show only slightly diminished efficiency as system size increases. In contrast to diurnal systems, annual storage systems perform efficiently in meeting the load of a passive or energy efficient building. E.A.K.

**N82-22676\*#** National Aeronautics and Space Administration, Washington, D. C.

**THE FINAL PROCEEDINGS OF THE SOLAR POWER SATELLITE PROGRAM REVIEW**

Jul. 1980 701 p refs Rev. held in Lincoln, Nebr., 22-25 Apr. 1980

(Contract DE-FG05-79ER-10116)

(NASA-TM-84183; NAS 1.15:84183; CONF-800491) Avail: NTIS HC A99/MF A01 CSCL 10A

The solar power satellite (SPS) concept defined as 'placing gigantic satellites in geosynchronous orbit to capture sunlight, changing the energy into an appropriate form for transmission to Earth, and introducing the energy into the electric power grid' is evaluated in terms of costs and benefits. The concept development and evaluation program is reviewed in four general areas: systems definition; environmental; societal; and comparative assessments. Specific factors addressed include: transportation, construction in space, methods of conversion of sunlight into energy, transmission to Earth, maintenance in orbit and decommissioning of satellites; environmental, political, and economic effects; and comparison of

SPS to other forms of power generation, both terrestrial and in space.

**N82-22677\*#** National Aeronautics and Space Administration, Washington, D. C.

**OVERVIEW OF SYSTEMS DEFINITION ACTIVITIES FOR SATELLITE POWER SYSTEMS**

F. C. SCHWENK *In its* The Final Proc. of the Solar Power Satellite Program Rev. p 21-35 Jul. 1980

Avail: NTIS HC A99/MF A01 CSCL 10A

Studies conducted by NASA of the Satellite Power System were reviewed and included considerations of the role of SPS as an energy system, space technology, ground systems, and environmental concerns. Various space transportation systems for placement of the SPS in an operational mode are discussed.

T.M.

**N82-22684\*#** General Electric Co., Schenectady, N. Y.

**INTEGRATION OF SPS WITH UTILITY SYSTEM NETWORKS**

B. M. KAUPANG *In* NASA, Washington The Final Proc. of the Solar Power Satellite Program Rev. p 99-102 Jul. 1980

Avail: NTIS HC A99/MF A01 CSCL 10A

The integration of Satellite Power System (SPS) power in electric utility power systems is discussed. Specifically, the nature of the power output variations from the spacecraft to the rectenna, the operational characteristics of the rectenna power, and the impacts on the electric utility system from utilizing SPS power to serve part of the system load are treated. It is concluded that if RF beam control is an acceptable method for power control, and that the site distribution of SPS rectennas do not cause a very high local penetration (40 to 50%), SPS may be integrated into electric utility system with a few negative impacts. Increased regulating duty on the conventional generation, and a potential impact on system reliability for SPS penetration in excess of about 25% appear to be two areas of concern.

M.G.

**N82-22685\*#** National Aeronautics and Space Administration, Lyndon B. Johnson Space Center, Houston, Tex.

**SPS COST METHODOLOGY AND SENSITIVITIES**

R. O. PILAND *In* NASA, Washington The Final Proc. of the Solar Power Satellite Program Rev. p 103-106 Jul. 1980

Avail: NTIS HC A99/MF A01 CSCL 10A

A total solar power satellite is defined and costs for such a program estimated. The program is assumed to consist of a number of phases from initial research to the completed production unit. Each phase represents an increasing commitment of resources as confidence in the ultimate success of the program grows. The total cost of the program through the first full-scale unit is estimated to be slightly over 100 billion dollars. The subsequent units are estimated to cost an average of 11.5 billion dollars per unit.

M.G.

**N82-22687\*#** European Space Technology Center, Noordwijk (Netherlands). Systems Engineering Dept.

**CRITICAL TECHNOLOGY AREAS OF AN SPS DEVELOPMENT AND THE APPLICABILITY OF EUROPEAN TECHNOLOGY**

D. KASSING and J. RUTH *In* NASA, Washington The Final Proc. of the Solar Power Satellite Program Rev. p 109-112 Jul. 1980 refs

Avail: NTIS HC A99/MF A01 CSCL 10A

Possible system development and implementation scenarios for the hypothetical European part of a cooperative Satellite Power System effort are discussed, and the technology and systems requirements which could be used as an initial guideline for further evaluation studies are characterized. Examples of advanced European space technologies are described including high power microwave amplifiers, antennas, advanced structures, multi-kilowatt solar arrays, attitude and orbit control systems, and electric propulsion.

L.F.M.

**N82-22694\*#** National Aeronautics and Space Administration, Lyndon B. Johnson Space Center, Houston, Tex.

**REFERENCE SYSTEM CHARACTERIZATION AND COST OVERVIEW**

R. O. PILAND *In* NASA, Washington The Final Proc. of the Solar Power Satellite Program Rev. p 142-145 Jul. 1980 refs

Avail: NTIS HC A99/MF A01 CSCL 10A  
A brief description of the necessary elements of the Satellite Power System is presented. This reference system provides the basis for making preliminary cost estimates.

L.F.M.

**N82-22695\*#** Argonne National Lab., Ill.

**SPS AND ALTERNATIVE TECHNOLOGIES COST AND PERFORMANCE EVALUATIONS**

M. E. SAMSA *In* NASA, Washington The Final Proc. of the Solar Power Satellite Program Rev. p 146-149 Jul. 1980

Avail: NTIS HC A99/MF A01 CSCL 10A

Cost estimates for production of the electrical energy needed in the early twenty-first century are provided. Costs and performance of the Satellite Power System are compared with alternative methods of producing electrical energy.

L.F.M.

**N82-22702\*#** Bechtel National, Inc., San Francisco, Calif.

**THE DESIGN OF LOW COST STRUCTURES FOR EXTENSIVE GROUND ARRAYS**

H. A. FRANKLIN and R. S. LEONARD *In* NASA, Washington The Final Proc. of the Solar Power Satellite Program Rev. p 185-188 Jul. 1980

Avail: NTIS HC A99/MF A01 CSCL 10A

The development of conceptual designs of solar array support structures and their foundations including considerations of the use of concrete, steel, aluminum, or timber are reported. Some cost trends were examined by varying selected parameters to determine optimum configurations. Detailed civil/structural design criteria were developed. Using these criteria, eight detailed designs for support structures and foundations were developed and cost estimates were made. As a result of the study wind was identified as the major loading experienced by these low height structures, whose arrays are likely to extend over large tracts of land. Proper wind load estimating is considered essential to developing realistic structural designs and achieving minimum cost support structures. Wind tunnel testing of a conceptual array field was undertaken and some of the resulting wind design criteria are presented. The SPS rectenna system designs may be less sensitive to wind load estimates, but consistent design criteria remain important.

M.D.K.

**N82-22715\*#** Rhode Island Univ., Kingston. Dept. of Electrical Engineering.

**PASSIVE SOLAR REFLECTOR SATELLITE REVISITED**

C. POLK and J. C. DALY *In* NASA, Washington The Final Proc. of the Solar Power Satellite Program Rev. p 231-233 Jul. 1980

Avail: NTIS HC A99/MF A01 CSCL 10A

Passive light weight reflectors in space which direct the incident solar energy to a specified location on the Earth surface are proposed as an alternative system for the solar power satellite to overcome conversion losses and to avoid the need for photovoltaic cells. On Earth, either photovoltaic cells or a steam turbine alternator on a solar tower, or a similar conventional, relatively high efficiency cycle are used for electricity generation. The constraints which apply to the design of the optical system if a single satellite is placed in geostationary orbit are outlined. A single lens and a two lens system are discussed.

J.M.S.

**N82-22720\*#** Boeing Aerospace Co., Seattle, Wash.

**PROTON DAMAGE ANNEALING KINETICS IN SILICON SOLAR CELLS**

W. E. HORNE, I. ARIMURA, and A. C. DAY *In* NASA, Washington The Final Proc. of the Solar Power Satellite Program Rev. p 254-257 Jul. 1980

Avail: NTIS HC A99/MF A01 CSCL 10A

Proton damage annealing as a method for prolonging the life of solar power systems in space is discussed. Variables are

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minimized and fundamental characteristics of proton damage annealing are considered. The usefulness of annealing for prolonging space missions is evaluated. A preliminary determination of optimum annealing conditions is made, and base data provided for more detailed research programs. J.D.

**N82-22721\*#** Little (Arthur D.), Inc., Cambridge, Mass.  
**EVALUATION OF SOLAR CELL MATERIALS FOR A SOLAR POWER SATELLITE**

P. E. GLASER, D. W. ALMGREN, and K. I. CSIGI /in NASA, Washington The Final Proc. of the Solar Power Satellite Program Rev. p 263-266 Jul. 1980 refs

Avail: NTIS HC A99/MF A01 CSCL 10A

Alternative solar cell materials being considered for the solar power satellite are described and price, production, and availability projections through the year 2000 are presented. The chief materials considered are silicon and gallium arsenide. J.D.

**N82-22745\*#** IBM Federal Systems Div., Westlake Village, Calif.

**SATELLITE POWER SYSTEM OPERATIONS**

F. L. PUGH and A. I. GORDON (Rockwell International, Seal Beach, Calif.) /in NASA, Washington The Final Proc. of the Solar Power Satellite Program Rev. p 368-371 Jul. 1980

Avail: NTIS HC A99/MF A01 CSCL 10A

A projection of the electrical energy demands over the next 30 to 50 years, coupled with reasonable assessments of known or developable energy sources, indicates that a shortage of electrical energy will occur about the turn of the century. Recognizing the criticality of such a shortage, the Department of Energy is currently evaluating alternative power generation concepts. One of these candidate concepts is the Satellite Power System. The power levels considered during the evaluation of the various satellite systems have ranged from 5 to 10 GW. It is apparent that, with this power level, both the satellite and the rectenna must be very large and encompass a large number of complex operational system activities. Major elements of the Satellite Power System (SPS) consist of a power satellite placed in a geosynchronous equatorial orbit, and a dedicated ground receiving station (GRS) located at a selected site within the continental United States. The nominal power output of the SPS is established at 5 gigawatts (5 million kilowatts) although, because of various system constraints or losses, it may actually produce between 4 and 5 gigawatts. N.W.

**N82-22748\*#** Institute for Telecommunication Sciences, Boulder, Colo.

**SUMMARY OF THE ELECTROMAGNETIC COMPATIBILITY EVALUATION OF THE PROPOSED SATELLITE POWER SYSTEM**

E. L. MORRISON, JR., W. B. GRANT, and K. C. DAVIS (Battelle Memorial Inst., Richland, Wash.) /in NASA, Washington The Final Proc. of the Solar Satellite Program Rev. p 414-418 Jul. 1980

Avail: NTIS HC A99/MF A01 CSCL 10A

The effects of the proposed solar power satellite (SPS) operations on electronic equipment and systems by fundamental, harmonic, and intermodulation component emissions from the orbital station; and the fundamental, harmonic, and structural intermodulation emissions from the rectenna site were evaluated. The coupling and affects interactions affecting a wide spectrum of electronic equipment are considered. The primary EMC tasking areas are each discussed separately. J.D.

**N82-22749\*#** National Radio Astronomy Observatory, Socorro, N. Mex.

**THE EFFECTS OF A SATELLITE POWER SYSTEM ON GROUND-BASED ASTRONOMY**

A. R. THOMPSON /in NASA, Washington The Final Proc. of the Solar Power Satellite Program Rev. p 419-422 Jul. 1980 refs Sponsored in part by NSF

Avail: NTIS HC A99/MF A01 CSCL 10A

The effects of power transmission from the solar power satellite and of radiation from the ground based rectennas on radio astronomy, radar astronomy, and optical astronomy are discussed. Interference sources, acceptable signal and noise levels, and conflicting site requirements for observatories and rectennas are considered. J.D.

**N82-22750\*#** Electromagnetic Compatibility Analysis Center, Annapolis, Md.

**THE EMC OF SATELLITE POWER SYSTEMS AND DOD C-E SYSTEMS**

J. H. ATKINSON and M. D. AASEN (ITT Research Inst., Annapolis, Md.) /in NASA, Washington The Final Proc. of the Solar Power Satellite Program Rev. p 424-427 Jul. 1980 refs

Avail: NTIS HC A99/MF A01 CSCL 10A

The solar power satellite (SPS) technical parameters that are needed to accurately assess the electromagnetic compatibility (EMC) between SPS systems and DoD communications-electronics (C-E) systems are identified and assessed. The type of electromagnetic interactions that could degrade the performance of C-E systems are described and the major military installations in the southwestern portions of CONUS where specially sensitive C-E systems are being used for combat training and evaluation are identified. Classes of C-E systems that are generally in the vicinity of these military installations are considered. The Technical parameters that govern the degree of compatibility of the SPS with these C-E systems, and some technical requirements that are necessary to ensure short-term and long-term EMC are identified. J.D.

**N82-22751\*#** Little (Arthur D.), Inc., Cambridge, Mass.  
**ENCOUNTERS BETWEEN SPS POWER BEAMS AND SATELLITES IN LOWER ORBITS**

P. K. CHAPMAN /in NASA, Washington The Final Proc. of the Solar Power Satellite Program Rev. p 428-430 Jul. 1980

Avail: NTIS HC A99/MF A01 CSCL 10A

Interference between the solar power satellite (SPS) power beam and other satellites in lower orbits is described. Measures which might be taken to reduce the frequency of beam/satellite encounters or to minimize the effects of the encounters are discussed. J.D.

**N82-22775#** Center for the Environment and Man, Inc., Hartford, Conn.

**SOLAR POWERED DESICCANT AIR CONDITIONING SYSTEM Final Report**

24 Jul. 1981 27 p refs

(Contract DE-AC02-76CS-52702; DE-AC02-77CS-34286;

E(11-1)-2702; E(11-1)-4286)

(DE82-002656; DOE/CS-52702/T1; DOE/CS-34286) Avail:

NTIS HC A03/MF A01

A solar-powered desiccant air conditioning system using silica gel was developed, and modifications to the existing unit and additional testing are proposed to demonstrate the feasibility of the unit. Conversion from a rotating bed to a fixed bed of silica gel is proposed. Some general plans for commercialization are briefly discussed. DOE

**N82-22776#** Porter (W. H.), Inc., Holland, Mich. Port-R-Span Div.

**PASSIVE AND HYBRID SOLAR MANUFACTURED HOUSING AND BUILDINGS. PHASE 1: TECHNICAL PROPOSAL Final Report**

K. F. OSIKA 1 Aug. 1981 49 p  
(Contract DE-FC02-80CS-30388)  
(DE82-002098; DOE/CS-30388/1) Avail: NTIS HC A03/MF A01

The design objective for manufacturing farrowing-nursery building for hog confinement which uses a minimal amount of winter heat and is relatively cool in summer is discussed. Savings are to be accomplished by using an air to air heat exchanger, a hot air collector, and a wood stove in place of backup bottle gas. Solar alternatives and design criteria are described. A thermal analysis was performed. DOE

**N82-22777#** Boeing Engineering and Construction, Seattle, Wash.

**SECOND-GENERATION HELIOSTAT DEVELOPMENT FOR SOLAR-CENTRAL RECEIVERS Final Report**

31 Mar. 1981 193 p Prepared for Sandia National Labs., Livermore, Calif.  
(Contract DE-AC04-76DP-00789)  
(DE82-001844; SAND-81-8175-VOL-1) Avail: NTIS HC A09/MF A01

A production heliostat for a 50 MW/sub e/ solar electric power plant is described. The detail design, along with trades, analyses, and testing in support of the design are presented. The collector subsystem's performance is assessed. Fabrication, checkout, and installation of two prototypes are described. DOE

**N82-22778#** Boeing Engineering and Construction, Seattle, Wash.

**SECOND-GENERATION HELIOSTAT DEVELOPMENT FOR SOLAR-CENTRAL RECEIVERS, DETAIL DESIGN REPORT. VOLUME 1, APPENDIX Final Report**

31 Mar. 1981 205 p Prepared for Sandia National Labs., Livermore, Calif.  
(Contract DE-AC04-76DP-00789)  
(DE82-001842; SAND-81-8175-VOL-1-APP-1) Avail: NTIS HC A10/MF A01

Details of design, analysis, and test of the heliostats are provided. The azimuth drive, bearing assembly, assembled gimbal, actuator drive assembly, reflectors, and control system are described. DOE

**N82-22779#** Boeing Engineering and Construction, Seattle, Wash.

**SECOND-GENERATION HELIOSTAT DEVELOPMENT FOR SOLAR-CENTRAL RECEIVERS: VOLUME 1, DETAIL DESIGN REPORT. APPENDIX 2 Final Report, 24 Jul. - 24 Oct. 1980**

WINSMITH (Ford Aerospace and Communications Corp.) et al. 31 Mar. 1981 392 p Prepared for Sandia National Labs., Livermore, Calif.  
(Contract DE-AC04-76DP-00789)  
(DE82-001843; SAND-81-8175-VOL-1-APP-2) Avail: NTIS HC A17/MF A01

Three different types of rotary drive and bearing assemblies are investigated. These drives are designed and sized to meet load and life requirements for an azimuth actuation system for a second generation heliostat program. A structural analysis of the actuator is included. Two other actuator types are briefly examined although they are sized to meet applicable load life specifications. The actuator design considered the most suitable for the applications consists of a small worm gear drive as the first reduction stage and of a differential planetary as the final reduction. DOE

**N82-22780#** Ford Motor Co., Dearborn, Mich.

**SECOND-GENERATION HELIOSTAT DEVELOPMENT FOR SOLAR-CENTRAL CENTRAL RECEIVERS. DETAIL DESIGN REPORT: VOLUME 2, APPENDICES I, J Final Report**

31 Mar. 1981 499 p Prepared for Boeing Engineering and Construction Prepared in cooperation with Ford Aerospace and Communications Corp.  
(Contract DE-AC04-76DP-00789)  
(DE82-001837; SAND-81-8175-VOL-2-APP-I AND J) Avail: NTIS HC A21/MF A01

A heliostat manufacturing study consisting of evaluations of variable cost and investment costs, program engineering, training, preactivation and launching, savings opportunities, and selling price is presented. Descriptions of the facilities and manufacturing plan are included. General support departments and systems and other backup data are included as well as detailed cost and process description data for the heliostat facet assembly. DOE

**N82-22784#** Messerschmitt-Boelkow-Blohm G.m.b.H., Ottobrunn (West Germany). Space Div.

**SPACE AND ENERGY: GLOBAL VIEWPOINT**

D. E. KOELLE 1981 13 p refs Presented at 1st Intern. Aerospace Symp., Le Bourget, 2-3 Jun. 1981; sponsored by AIAA/Aerosalon  
(MBB-UR-489-81-O) Avail: NTIS HC A02/MF A01

The potential contributions from space technology to solving the future world energy problem are addressed. The basic problem is created by the depletion of the fossile fuels in the next century. The replacement of oil, gas and coal is only feasible by nuclear power and solar energy. In the first case space technology can contribute to making the terrestrial storage of radioactive waste much less dangerous and more acceptable by expediting the highly radioactive components (only 3%) into space. In the case of solar energy space technology can contribute large solar power stations in space, providing energy via microwaves to special rectenna sites. J.M.S.

**N82-22785#** Kloeckner und Co. Waermetechnik, Hechingen (West Germany).

**DEVELOPMENT OF CONTROL SYSTEMS FOR SOLAR WATER AND SOLAR SPACE HEATING EQUIPMENT. CHOICE OF HEAT CONDUCTING FLUID. TESTING Final Report, Apr. 1980**

H. MEYER Bonn Bundesministerium fuer Forschung und Technologie Nov. 1981 81 p refs In GERMAN; ENGLISH summary Sponsored by Bundesministerium fuer Forschung und Technologie  
(BMFT-FB-T-81-185; ISSN-0340-7608) Avail: NTIS HC A05/MF A01; Fachinformationszentrum, Karlsruhe, West Germany DM 17,20

Flat plate collector systems suitable for hot water supply, swimming pool heating, and auxiliary space heating were developed. A control and ready made packaged pipe assembly, adapted to synthetic fluid, was developed. A heat transfer fluid was selected, pumps, safety devices, armatures and seals were tested for their long term performance. External heat exchangers for simple and cascade arrangement of the hot water tanks were tested. It is found that the channel design of a roll bonded absorber has only limited effect on collector performance if the channel width approximates the space between the plates. Systems already installed work satisfactorily. Author (ESA)

**N82-22786#** Fondazione Ugo Bordoni, Rome (Italy).

**SOLAR RADIATION CHARACTERISTICS AND PREDICTION METHODS [CARATTERISTICHE METODI DI PREVISIONE DELLA RADIAZIONE SOLARE]**

F. BARBALISCA Jun. 1981 52 p refs In ITALIAN Sponsored by Ente Nazionale per l'Energia Elettrica  
(FUB-7-1981) Avail: NTIS HC A04/MF A01

Mathematical and statistical studies were carried out in order to provide a ground level solar radiation estimation, starting from meteorological data for given locations. Available insolation and meteorological historical series of Italian localities were used. Solar energy averaged over 24 hr periods is predictable with acceptable

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accuracy and, in certain cases, hourly energy distribution data can be obtained with an accuracy level sufficient for passive solar energy system design. For large active solar energy systems, further studies and detailed measurements are required. Author (ESA)

**N82-22788#** Kernforschungsanlage, Juelich (West Germany). Inst. fuer Kernphysik.

### TEST STATION FOR SOLAR COLLECTORS IN BRAZIL Final Report, Feb. 1981

J. ANHALT, K. MASSMEYER, and H. J. STEIN Bonn Bundesministerium fuer Forschung und Technologie Dec. 1981 77 p refs In GERMAN; ENGLISH summary Sponsored by Bundesministerium fuer Forschung und Technologie Original contains color illustrations (BMFT-FB-T-81-224; ISSN-0340-7608) Avail: NTIS HC A05/MF A01; Fachinformationszentrum, Karlsruhe, West Germany DM 15,26

A test facility for solar collector systems, operating in the temperature range above 100 C, was developed. Research and development programs for the utilization of solar energy are discussed. Conversion efficiency and heat loss measurements relative to experimental collectors under operational climatic conditions are presented. Meteorological data acquisition and measurement data processing are explained. Availability of the facility for further studies is summarized, including methodology for choice and construction of solar energy system components.

Author (ESA)

**N82-23149#** Messerschmitt-Boelkow-Blohm G.m.b.H., Ottobrunn (West Germany).

### A POINT FOCUSING COLLECTOR FOR AN INTEGRATED WATER/POWER COMPLEX

H. ZEWE, G. SCHMIDT, and S. MOUSTAFA In its Res. and Develop. at MBB. Tech. and Sci. Publ., 1981 17 p 1981 refs Presented at 20th Intern. Conf. on Cooperation Mediterranean pour l'Energie Solaire, Rabat, Morocco, 23-27 Nov. 1981

(MBB-UR-579-81-OE) Avail: NTIS HC A09/MF A01

A point focusing parabolic dish was developed in order to deliver process heat and as a solar collector for small solar thermal power stations. The utilization potential of the point focusing parabolic dish was identified and its main design parameters are summarized. The utilization of the collector as primary energy source in a food/water/power complex was tested. In its present configuration, the system is capable of delivering process heat for the temperature range from 150 to 500 C. This point focusing parabolic dish is identified as the most promising solar collector for small solar thermal power stations. Fifty-six dishes were assembled in a 100 kW (electric)/500 kW (thermal) food/water/power complex, which is in operation in the Kuwait desert. The dominating factors for cost reduction are discussed.

Author (ESA)

**N82-23353\*#** Societe Europeenne de Propulsion, Vernon (France).

### DESIGN ASPECTS OF A SOLAR ARRAY DRIVE FOR SPOT, WITH A HIGH PLATFORM STABILITY OBJECTIVE

J. CABILLIC, J. P. FOURNIER, P. ANSTETT, M. SOULIAC, and G. THOMIN (CNES) In NASA. Kennedy Space Center The 16th Aerospace Mech. Symp. p 143-157 May 1981 Prepared in cooperation with MATRA

Avail: NTIS HC A15/MF A01 CSCL 131

A solar array drive mechanism (MEGS) for the SPOT platform, which is a prototype of a multimission platform, is described. High-resolution cameras and other optical instruments are carried by the platform, requiring excellent platform stability in order to obtain high-quality pictures. Therefore, a severe requirement for the MEGS is the low level of disturbing torques it may generate considering the 0.6 times 10 to the minus 3 power deg/sec stability required. The mechanical design aspects aiming at reducing the mean friction torque, and therefore its fluctuations, are described as well as the method of compensation of the motor imperfections.

It was concluded, however, that this is not sufficient to reach the stability requirement. M.D.K.

**N82-23359\*#** British Aerospace Dynamics Group, Bristol (England).

### A DEPLOYMENT MECHANISM FOR THE DOUBLE ROLL-OUT FLEXIBLE SOLAR ARRAY ON THE SPACE TELESCOPE

T. R. CAWSEY In NASA. Kennedy Space Center The 16th Aerospace Mech. Symp. p 223-233 May 1982 refs Avail: NTIS HC A15/MF A01 CSCL 131

A roll-out flexible array which provides more than 4 kW of power for the space telescope was developed. The Array is configured as two wings. The deployment mechanism for each wing is based on flight-proven FRUSA design. Modifications have been incorporated to accommodate an increase in size and mission requirements. The assembly and operation of the deployment mechanism are described together with environmental and functional tests results. Author

**N82-23368#** Mid-American Solar Energy Complex, Minneapolis, Minn.

### AUDIO-VISUAL SUMMARY OF PASSIVE SOLAR COMMERCIAL BUILDINGS DEVELOPMENT IN THE MASEC REGION

Aug. 1981 10 p

(Contract DE-AC02-79CS-30151)

(DE82-003136; MASEC-R-81-039; P-104-2) Avail: NTIS HC A02/MF A01

An audio-visual presentation documenting the use of passive solar technologies in commercial buildings within the Mid-American Region is summarized. The presentation consists of 50 35-millimeter slides with accompanying narrative. The slide show gives a brief introduction to the use of direct gain, indirect gain, and isolated gain systems with commercial examples of each. DOE

**N82-23650\*#** Jet Propulsion Lab., California Inst. of Tech., Pasadena.

### PROCEEDINGS OF THE LOW-COST SOLAR ARRAY WAFERING WORKSHOP

A. D. MORRISON 1 Feb. 1982 300 p refs Workshop held in Phoenix, Ariz., 8-10 Jun. 1981

(Contract NAS7-100; DE-A101-76ET-20356)

(NASA-CR-168847; JPL-PUB-82-9; DOE/JPL-1012-66; NAS 1.26:168847) Avail: NTIS HC A13/MF A01 CSCL 10A

The technology and economics of silicon ingot wafering for low cost solar arrays were discussed. Fixed and free abrasive sawing wire, ID, and multiblade sawing, materials, mechanisms, characterization, and innovative concepts were considered.

**N82-23651\*#** Jet Propulsion Lab., California Inst. of Tech., Pasadena.

### LSA PROJECT PERSPECTIVE OF WAFERING TECHNOLOGY

K. M. KOLIAD In its Proc. of the Low-Cost Solar Array Wafering Workshop p 3-11 1 Feb. 1982

Avail: NTIS HC A13/MF A01 CSCL 10A

The economics and techniques for eliminating wafering as a part of ingot technology in the production of silicon sheets for photovoltaic applications are considered. Technical progress in both ingot and non-ingot technologies for the low cost solar array project is described in the context of process economics. The critical areas of research in wafering are delineated and their payoff potential discussed. J.D.

**N82-23652\*#** Pennsylvania Univ., Philadelphia.

### COMPARISON OF VARIOUS SILICON SAWING METHODS

M. WOLF In JPL Proc. of the Low-Cost Solar Array Wafering Workshop p 13-23 1 Feb. 1982 refs

Avail: NTIS HC A13/MF A01 CSCL 10A

The technology and economics of four methods of wafering silicon boules of large cross section are described. Slurry sawing using either blades or wires, and fixed abrasive sawing using the ID saw or by the FAST method, having the abrasive attached to wires which are arranged in a blade pack, are considered. The

technical performance of each method is evaluated and cost/price estimates are summarized. J.D.

**N82-23653\*#** ARCO Solar, Inc., Chatsworth, Calif.

**ARCO SOLAR, INCORPORATED: THE INDUSTRIAL POINT OF VIEW**

J. W. YERKES *In JPL Proc. of the Low-Cost Solar Array Wafering Workshop p 25-28 1 Feb. 1982*  
 Avail: NTIS HC A13/MF A01 CSCL 10A

The status of technological developments in silicon wafer production is summarized. Wafer growing and casting/sawing methods are considered. aba J.D.

**N82-23654\*#** Applied Solar Energy Corp., City of Industry, Calif.

**SOME DISCONNECTED SPECULATIONS ON SLICING SILICON**  
 P. A. ILES *In JPL Proc. of the Low-Cost Solar Array Wafering Workshop p 29-32 1 Feb. 1982*

Avail: NTIS HC A13/MF A01 CSCL 10A

The basic principles for qualifying silicon wafering methods are summarized, and unconventional methods of wafering was discussed. Methods of cleaving analogous to diamond cutting, geological processes employing the expansion of freezing water, and karate chops are touched upon. J.D.

**N82-23665\*#** Applied Solar Energy Corp., City of Industry, Calif.  
**FIELD EXPERIENCE WITH VARIOUS SLICING METHODS**

H. I. YOO *In JPL Proc. of the Low-Cost Solar Array Wafering Workshop p 179-185 1 Feb. 1982* Sponsored in part by DOE  
 Avail: NTIS HC A13/MF A01 CSCL 10A

Wafer slicing using internal diameter (ID) saw, multiblade slurry (MBS) saw and multiwire slurry (MWS) saw techniques were evaluated. Wafer parameters such as bow, taper, and roughness which may not be important factors for solar cell fabrication, were considerably better for ID saw than those of the MBS and MWS saw. Analysis of add-on slicing cost indicated that machine productivity seems to be a major limiting factor for ID saw, while expendable material costs are a major factor for both MBS and MWS saw. Slicing experience indicated that the most important factors controlling final wafer cost are: (1) silicon cost (wafer thickness + kerf loss); (2) add-on slicing cost, and (3) mechanical yield. There is a very strong interaction between these parameters, suggesting a necessity of optimization of these parameters.

A.R.H.

**N82-23666\*#** Jet Propulsion Lab., California Inst. of Tech., Pasadena.

**SOME TRADEOFFS IN INGOT SHAPING AND PRICE OF SOLAR PHOTOVOLTAIC MODULES**

T. DAUD *In its Proc. of the Low-Cost Solar Array Wafering Workshop p 187-196 1 Feb. 1982* refs  
 Avail: NTIS HC A13/MF A01 CSCL 10A

Growth of round ingots is cost-effective for sheets but leaves unused space when round cells are packed into a module. This reduces the packing efficiency, which approaches 95% for square cells, to about 78% and reduces the conversion efficiency of the module by the same ratio. Shaping these ingots into squares with regrowth of cut silicon improves the packing factor, but increases growth cost. The cost impact on solar cell modules was determined by considering shaping ingots in stages from full round to complete square. The sequence of module production with relevant price allocation guidelines is outlined. The severe penalties in add-on price due to increasing slice thickness and kerf are presented. Trade-offs between advantages of recycling silicon and shaping costs are developed for different slicing scenarios. It is shown that shaping results in cost saving of up to 21% for a 15 cm dia. ingot. A.R.H.

**N82-23667\*#** Jet Propulsion Lab., California Inst. of Tech., Pasadena.

**SENSITIVITY ANALYSIS OF ADD-ON PRICE ESTIMATE FOR SELECT SILICON WAFERING TECHNOLOGIES**

A. R. MOKASHI *In its Proc. of the Low-Cost Solar Array Wafering Workshop p 197-209 1 Feb. 1982* refs  
 Avail: NTIS HC A13/MF A01 CSCL 10A

The cost of producing wafers from silicon ingots is a major component of the add-on price of silicon sheet. Economic analyses of the add-on price estimates and their sensitivity internal-diameter (ID) sawing, multiblade slurry (MBS) sawing and fixed-abrasive slicing technique (FAST) are presented. Interim price estimation guidelines (IPEG) are used for estimating a process add-on price. Sensitivity analysis of price is performed with respect to cost parameters such as equipment, space, direct labor, materials (blade life) and utilities, and the production parameters such as slicing rate, slices per centimeter and process yield, using a computer program specifically developed to do sensitivity analysis with IPEG. The results aid in identifying the important cost parameters and assist in deciding the direction of technology development efforts.

A.R.H.

**N82-23668\*#** Semix, Inc., Gaithersburg, Md.

**WAFERING ECONOMIES FOR INDUSTRIALIZATION FROM A WAFER MANUFACTURER'S VIEWPOINT**

T. P. ROSENFELD and F. P. FUERST *In JPL Proc. of the Low-Cost Solar Array Wafering Workshop p 211-229 1 Feb. 1982* refs

Avail: NTIS HC A13/MF A01 CSCL 10A

The key technical limitations which inhibit the lowering of value-added costs for state-of-the-art wafering techniques are assessed. From the best experimental results to date, a projection was made to identify those parts of each system which need to be developed in order to meet or improve upon the value-added cost reduction necessary for \$0.70/Wp photovoltaics modules.

A.R.H.

**N82-23669\*#** Crystal Systems, Inc., Salem, Mass.

**OVERVIEW OF A NEW SLICING METHOD: FIXED ABRASIVE SLICING TECHNIQUE (FAST)**

F. SCHMID, M. B. SMITH, and C. P. KHATTAK *In JPL Proc. of the Low-Cost Solar Array Wafering Workshop p 233-241 1 Feb. 1982* refs Sponsored in part by DOE

Avail: NTIS HC A13/MF A01 CSCL 10A

The fixed abrasive slicing technique (FAST) was developed to slice silicon ingots more effectively. It was demonstrated that 25 wafers/cm can be sliced from 10 cm diameter and 19 wafers/cm from 15 cm diameter ingots. This was achieved with a combination of machine development and wire-blade development programs. Correlation was established between cutting effectiveness and high surface speeds. A high speed slicer was designed and fabricated for FAST slicing. Wirepack life of slicing three 10 cm diameter ingots was established. Electroforming techniques were developed to control widths and prolong life of wire-blades. Economic analysis indicates that the projected add-on price of FAST slicing is compatible with the DOE price allocation to meet the 1986 cost goals. M.G.

**N82-23672\*#** Silicon Technology Corp., Oakland, N. J.

**ID SLICING AND THE AUTOMATED FACTORY**

T. LEWANDOWSKI *In JPL Proc. of the Low-Cost Solar Array Wafering Workshop p 253-258 1 Feb. 1982*

Avail: NTIS HC A13/MF A01 CSCL 10A

The automation of the slicing system utilizing internal-diameter saws for the production of the silicon wafers used in solar arrays is discussed. It is argued that saw productivity can be increased by reducing silicon waste, decreasing usage of consumables, keeping the saw slicing, and increasing the cutting speed. Several machine enhancements utilizing automatic control are discussed. The need for record keeping to anticipate maintenance operations is noted, and a digital serial communication interface with the microprocessor-based saws is recommended. Distributed control

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of the manufacturing process is discussed in detail, and is recommended as a method for increasing productivity. R.J.F.

**N82-23681#** Midwest Research Inst., Golden, Colo. Solar Energy Research Inst.

### **SOLAR ENERGY LEGAL BIBLIOGRAPHY SECOND UPDATE**

S. WEINER May 1981 94 p

(Contract EG-77-C-01-4042)

(SERI/TR-744-876) Avail: NTIS HC A05/MF A01

Approximately 100 publications were abstracted for their legal and policy content with respect to solar energy. Emphasis was on legal barriers and incentives to solar energy development. Subject arrangement covers 24 categories. An author index is included.

N.W.

**N82-23741#** Black and Veatch Consulting Engineers, Kansas City, Mo.

### **SOLAR COGENERATION FACILITY: CIMARRON RIVER STATION, CENTRAL TELEPHONE AND UTILITIES-WESTERN POWER. EXECUTIVE SUMMARY**

7 Aug. 1981 38 p 3 Vol.

(Contract DE-AC03-81SF-11439)

(DE82-001898; DOE/SF-11439/1-VOL-1) Avail: NTIS HC A03/MF A01

A brief overview of the conceptual design of a solar central receiver system integrated with an existing cogeneration facility is provided. A synopsis of the performance, an economic evaluation, and an assessment of the concept from the site owner's perspective are given.

DOE

**N82-23742#** Black and Veatch Consulting Engineers, Kansas City, Mo.

### **SOLAR COGENERATION FACILITY: CIMARRON RIVER STATION, CENTRAL TELEPHONE AND UTILITIES-WESTERN POWER Final Report**

7 Aug. 1981 24 p refs 3 Vol.

(Contract DE-AC03-81SF-11439)

(DE82-001921; DOE/SF-11439/1-VOL-2) Avail: NTIS HC A02/MF A01

A site-specific conceptual design and evaluation of a solar central receiver system integrated with an existing cogeneration facility are described. The system generates electricity and delivers a portion of that electricity and process steam to a natural gas processing plant. Early in the project, tradeoff studies were performed to establish key system characteristics. As a result of these studies the use of energy storage was eliminated, the size of the solar facility was established at 37.13 MW (sub t), and other site-specific features were selected. The conceptual design addressed critical components and system interfaces. The result is a hybrid solar/fossil central receiver facility which utilizes a collector system of Department of Energy second generation heliostats.

DOE

**N82-23743#** Black and Veatch Consulting Engineers, Kansas City, Mo.

### **SOLAR COGENERATION FACILITY: CIMARRON RIVER STATION, CENTRAL TELEPHONE AND UTILITIES-WESTERN POWER, APPENDICES**

7 Aug. 1981 24 p refs

(Contract DE-AC03-81SF-11439)

(DE82-001852; DOE/SF-11439/1-VOL-3) Avail: NTIS HC A10/MF A01

The characteristics, design requirements, and environmental requirements for the solar cogeneration facility are specified, including conceptual design, performance, and economic data for the solar facility and certain design data for the existing facility. A detailed breakdown of the construction cost estimate is provided.

DOE

**N82-23745#** JRB Associates, McLean, Va.

### **DESIGN HANDBOOK FOR PHOTOVOLTAIC-POWER SYSTEMS: SIMPLIFIED METHODS FOR UTILITY INTERCONNECTED SYSTEMS**

Y. P. GUPTA and S. K. YOUNG Oct. 1981 233 p refs

(Contract DE-AC04-76DP-00789)

(DE82-003909; SAND-80-7147-VOL-2) Avail: NTIS HC A11/MF A01

Two nomograms are presented, one for computing the economic feasibility of a photovoltaic system, and the other for sizing the preliminary PV array area. Worksheets are provided for computing PV system economic feasibility, preliminary collector area estimates, electrical loads, system output and costs, present worth analysis, solar fraction, array sizing analysis, and thermal analysis for combined PV/thermal systems. Climate statistics and insolation, shading factors, daytime solar fraction coefficients and present worth factors are tabulated.

DOE

**N82-23746#** Sandia Labs., Albuquerque, N. Mex.

### **INTERMEDIATE PHOTOVOLTAIC SYSTEM APPLICATION EXPERIMENT OPERATIONAL PERFORMANCE REPORT. VOLUME 4: FOR NEWMAN POWER STATION, EL PASO, TEXAS**

Oct. 1981 16 p refs Prepared in cooperation with Boeing Computer Services Co., Seattle

(Contract DE-AC04-76DP-00789)

(DE82-002681; SAND-81-7086/4) Avail: NTIS HC A02/MF A01

Performance data are given for a photovoltaic power supply at a Texas utility for the month of August 1981. Included are: total and daily electrical energy production; total monthly and daily incident solar energy; monthly and daily efficiency; graphs of energy production as a function of power level, voltage, cell temperature, and hour of the day; system availability; heating and cooling degree days, average monthly insolation, ambient temperature and wind speed, and average insolation, ambient temperature, cell temperature, and wind speed graphed versus hour of the day.

DOE

**N82-23747#** Sandia Labs., Albuquerque, N. Mex.

### **INTERMEDIATE PHOTOVOLTAIC SYSTEM APPLICATION EXPERIMENT OPERATIONAL EXECUTIVE SUMMARY. VOLUME 3: FOR LOVINGTON SQUARE SHOPPING CENTER, LOVINGTON, NEW MEXICO**

Oct. 1981 7 p refs

(Contract DE-AC04-76DP-00789)

(DE82-003082; SAND-81-7099/3) Avail: NTIS HC A02/MF A01

For the month of August 1981, daily and monthly electricity production and daily, monthly insolation and monthly array efficiency are given. These data are given for a 100 kW photovoltaic flat panel facility at a New Mexico shopping center.

DOE

**N82-23751#** Brookhaven National Lab., Upton, N. Y. Dept. of Energy and Environment.

### **LOW COST SOLAR ENERGY COLLECTION FOR COOLING APPLICATIONS**

W. G. WILHELM Jun. 1981 19 p refs

(Contract DE-AC02-76CH-00016)

(DE82-003255; BNL-51408) Avail: NTIS HC A02/MF A01

Solar energy collector designs utilizing thin-film polymeric materials in the absorber and glazing are investigated. The main objective is dramatic cost reduction consistent with acceptable performance and life. These collectors now appear capable of high temperature applications including desiccant and absorption cooling (1500 to 2000 F). The performance and economics of the thin-film collector are compared with those of conventional flat-plate designs in cooling applications.

DOE

**N82-23752#** Sandia Labs., Albuquerque, N. Mex.  
**ANALYSIS OF 70-TUBE PILOT-PLANT SOLAR-RECEIVER-PANEL TEST DATA**

L. N. KMETIK and R. K. BYERS Aug. 1981 65 p refs

(Contract DE-AC04-76DP-00789)

(DE82-001728; SAND-81-1220) Avail: NTIS HC A04/MF A01

An analytic model for a solar receiver boiler panel was developed, using the RELAP4 nuclear plant systems thermal hydraulic computer code. Results are compared to other computer calculations and experimental data. The test panels were prototypes of panels to be used in the Barstow 10 MWe solar electric pilot power plant central receiver. Steady state operating conditions for a given incident heat flux were calculated from a zero power cold water startup. The effects of incident flux axial profile shape and of lateral flux gradients were studied, as was the dynamic response of the model to flux and flow transients. The nodalization detail required for accurate simulation was also determined. DOE

**N82-23755#** Sandia Labs., Albuquerque, N. Mex.  
**INTERMEDIATE PHOTOVOLTAIC SYSTEM APPLICATION EXPERIMENT OPERATIONAL PERFORMANCE: EXECUTIVE SUMMARY. VOLUME 1: LOVINGTON SQUARE SHOPPING CENTER, LOVINGTON, NEW MEXICO**

Sep. 1981 16 p refs Prepared in cooperation with Boeing Computer Services Co., Seattle

(Contract DE-AC04-76DP-00789)

(DE82-001710; SAND-81-7099/1) Avail: NTIS HC A02/MF A01

For the months of April through June 1981, performance data are given for a 100 kW photovoltaic flat panel grid connected facility at a New Mexico shopping center. For each month, the monthly total electrical energy production and insolation, and array efficiency are given and the daily energy produced and insolation are graphed. DOE

**N82-23756#** Sandia Labs., Albuquerque, N. Mex.  
**INTERMEDIATE PHOTOVOLTAIC SYSTEM APPLICATION EXPERIMENT OPERATIONAL PERFORMANCE: EXECUTIVE SUMMARY. VOLUME 2: NEWMAN POWER STATION, EL PASO, TEXAS**

Sep. 1981 23 p Prepared in cooperation with Boeing Computer Services Co., Seattle

(Contract DE-AC04-76DP-00789)

(DE82-001711; SAND-81-7100/2) Avail: NTIS HC A02/MF A01

For the months of February through July 1981, except June, performance data are given for a 20 kWg photovoltaic flat panel power system for an uninterruptable power supply load in Texas. For each month, the monthly total electrical energy production and insolation and array efficiency are given and the daily energy production and insolation are graphed. DOE

**N82-23757#** Sandia Labs., Albuquerque, N. Mex.  
**INTERMEDIATE PHOTOVOLTAIC SYSTEM APPLICATION EXPERIMENT OPERATIONAL PERFORMANCE: EXECUTIVE SUMMARY. VOLUME FOR BEVERLY HIGH SCHOOL, BEVERLY, MASSACHUSETTS**

Sep. 1981 10 p refs Prepared in cooperation with Boeing Computer Services Co., Seattle

(Contract DE-AC04-76DP-00789)

(DE82-001726; SAND-81-7102/1) Avail: NTIS HC A02/MF A01

For the month of July 1981, performance data are given for a grid connected 100 kW photovoltaic flat panel power system at a high school in Massachusetts. The total electrical energy produced and solar energy incident on the solar cells, array and system efficiency, capacity factor, and insolation are given for the month and the daily energy production and incident solar energy are graphed. DOE

**N82-23758#** Sandia Labs., Albuquerque, N. Mex.  
**INTERMEDIATE PHOTOVOLTAIC SYSTEM APPLICATION EXPERIMENT OPERATIONAL PERFORMANCE: EXECUTIVE SUMMARY. VOLUME 1 FOR MT. LAGUNA RADAR STATION, MT. LAGUNA, CALIFORNIA**

Sep. 1981 28 p refs Prepared in cooperation with Boeing Computer Services Co., Seattle

(Contract DE-AC04-76DP-00789)

(DE82-001727; SAND-81-7104/1) Avail: NTIS HC A03/MF A01

For the months of January through July 1981, performance data are given for a photovoltaic array with two different types of photovoltaic modules, a paralleling, and monitoring panel, a power conversion subsystem, and a data acquisition system. For each month, the monthly total electrical energy production and insolation, array efficiency, system efficiency, and capacity factor are given and the daily energy production and insolation are graphed. DOE

**N82-23765#** McDonnell-Douglas Astronautics Co., Huntington Beach, Calif. Solar Energy Systems Dept.

**FORT HOOD SOLAR COGENERATION FACILITY CONCEPTUAL DESIGN STUDY. VOLUME 1: TECHNICAL REPORT Final Technical Report**

Aug. 1981 397 p 2 Vol.

(Contract DE-AC03-81SF-11495)

(DE82-000836; DOE/SF-11495/T1-VOL-1; MDC-G-9716-VOL-1)

Avail: NTIS HC A17/MF A01

A solar heated heat transfer salt provides heat to a steam generation and provides space heating and air conditioning and hot water for the complex. The site and its climate are described briefly. Candidate site specific system configurations, technology assessments, system sizing, and the results of numerous trade studies leading toward the selection of the preferred system configuration are presented. A system level conceptual design of the cogeneration facility is presented, and the conceptual design of the subsystems (heliostats, receiver, tower, energy transport and storage, fossil energy subsystem, electric power generation subsystem, control, space conditioning and domestic hot water subsystem) are described. Results of the economic analysis of the cogeneration facility are presented, including a description of analysis methods used, assumptions and rationale, simulation models used, a brief summary of capital and operations and maintenance costs, fuel savings, results of the economic evaluations and an economic scenario for future applications. T.M.

**N82-23766#** McDonnell-Douglas Astronautics Co., Huntington Beach, Calif. Solar Energy Program Dept.

**FORT HOOD SOLAR COGENERATION FACILITY CONCEPTUAL DESIGN STUDY. VOLUME 2: SYSTEM SPECIFICATION Final Technical Report**

Aug. 1981 324 p refs 2 Vol.

(Contract DE-AC03-81SF-11495)

(DE82-001579; DOE/SF-11495/T1-VOL-2; MDC-G-9716-VOL-2)

Avail: NTIS HC A14/MF A01

The characteristics and design and the environmental requirements for a solar cogeneration facility at a Texas military facility are specified. In addition, the conceptual design and performance characteristics, cost and economic data and other information for the cogeneration facility designed to meet the requirements are summarized. DOE

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**N82-23767#** General Electric Co., Philadelphia, Pa. Advanced Energy Programs Dept.

**TEXASGULF SOLAR COGENERATION PROGRAM, VOLUME 1 Final Report, 1 Sep. 1980 - 1 Jun. 1981**

D. J. BISANTZ, K. D. BISHOP (Texasgulf Chemicals Co.), W. HERRINGTON (Texasgulf Chemicals Co.), H. E. JONES, P. KARNOSKI (Brown and Root Development, Inc.), and S. I. SCHWARTZ Jun. 1981 158 p 2 Vol.

(Contract DE-AC03-80SF-11437)

(DE82-001900; DOE/SF-11437/T4-VOL-1) Avail: NTIS HC A05/MF A01

A site specific conceptual design was generated for a near term Solar Cogeneration Facility based upon solar central receiver technology. Various system trade studies were conducted to select an optimum system configuration for the selected industrial site, as well as a configuration with the potential for wide industrial applicability. System performance and cost estimates were prepared and utilized to assess the economics of the near term facility, as well as a similar commercial size facility. A development plan was then generated with the objective of efficiency achieving facility operation by 1985. The selected industrial site is Texasgulf's Comanche Creek Sulfur Mine near Fort Stockton, Texas. The Solar Cogeneration Facility will operate 24 hours per day, 365 day per year in the hybrid (solar and fossil) or fossil only modes of operation. High reliability, a definite requirement for Frasch process sulfur mining as well as other industrial process heat operations, is incorporated into the design. DOE

**N82-23768#** General Electric Co., Philadelphia, Pa. Advanced Energy Programs Dept.

**TEXASGULF SOLAR COGENERATION PROGRAM. VOLUME 2: APPENDICES Final Report**

D. J. BISANTZ 1 Jun. 1981 96 p refs

(Contract DE-AC03-80SF-11437)

(DE82-001848; DOE/SF-11437/T4-VOL-2) Avail: NTIS HC A05/MF A01

The subsystem characteristics and required operating modes for a solar cogeneration facility to be located at a Texas sulfur mine are specified. Cost estimates for six storage system concepts are summarized, and the costs of storage media are tabulated. Data for use in estimating the cost of storage tanks, and heat exchangers and a methodology for estimating indirect costs are given. The cartesian coordinates of each of the 588 heliostats in the collector field are given. A water steam receiver loss computer program is listed. DOE

**N82-23772#** Boeing Computer Services, Inc., Seattle, Wash.  
**INTERMEDIATE PHOTOVOLTAIC SYSTEM APPLICATION EXPERIMENT OPERATIONAL EXECUTIVE SUMMARY. VOLUME 2: FOR LOVINGTON SQUARE SHOPPING CENTER, LOVINGTON, NEW MEXICO**

Oct. 1981 7 p refs Prepared for Sandia National Labs. 3 Vol.

(Contract DE-AC04-76DP-00789)

(DE81-003081; SAND-81-7099/2-VOL-2) Avail: NTIS HC A02/MF A01

For the month of July 1981, the daily and monthly insolation, daily and monthly electricity production, and monthly array efficiency are given for a 100 kW photovoltaic flat panel. The facility was located at a New Mexico shopping center. (LEW) DOE

**N82-23773#** Boeing Computer Services, Inc., Seattle, Wash.  
**INTERMEDIATE PHOTOVOLTAIC SYSTEM APPLICATION EXPERIMENT OPERATIONAL EXECUTIVE SUMMARY. VOLUME 3: FOR NEWMAN POWER STATION, EL PASO, TEXAS**

Oct. 1981 7 p refs Prepared for Sandia National Labs. 3 Vol.

(Contract DE-AC04-76DP-00789)

(DE82-003088; SAND-81-7100/3-VOL-3) Avail: NTIS HC A02/MF A01

For the month of August 1981, the daily and monthly insolation, daily and monthly energy production, and monthly array efficiency

are given for a 20 kW photovoltaic flat panel power system. The panel system is for an uninterruptable power supply load at a Texas utility. (LEW) DOE

**N82-23800#** Sandia Labs., Livermore, Calif.

**CHARACTERIZATION OF THE CORROSION ENVIRONMENT OF THE DESERT NEAR BARTSTOW, CALIFORNIA**

D. A. HUGHES Sep. 1981 30 p refs

(Contract DE-AC04-76DP-00789)

(DE82-003876; SAND-81-8252) Avail: NTIS HC A03/MF A01

The corrosion characteristics of the desert atmosphere environment near Bartstow, CA were evaluated for the solar pilot plant receiver panel. Potential degradation mechanisms considered were not corrosion from molten salts and stress corrosion cracking in aqueous environments. The possibility of degradation from these mechanisms depends on the chemical composition of airborne particulates, aerosols, and gases. These particulates and aerosol were collected near the pilot plant site and analyzed for water and acid soluble Na(+), Mg(+ +), Li(+), S(-), SO4(-), and Cl(-). Comparison and evaluation of the quantities of these ions present with those necessary for corrosion indicate that external corrosion of the receiver due to the desert atmosphere environment is unlikely. DOE

**N82-24394#** National Bureau of Standards, Washington, D.C. National Engineering Lab.

**SOLAR INDUSTRIAL PROCESS HEAT SYSTEMS: AN ASSESSMENT OF STANDARDS FOR MATERIALS AND COMPONENTS**

W. J. ROSSITER and W. E. SHIPP Sep. 1981 98 p refs Sponsored in part by DOE

(PB82-133703; NBSIR-81-2381) Avail: NTIS HC A05/MF A01 CSCL 13A

A study was conducted to obtain information on the performance of materials and components in operational solar industrial process heat (PH) systems, and to provide recommendations for the development of standards including evaluative test procedures for materials and components. An assessment of the needs for standards for evaluating the long-term performance of materials and components of IPH systems was made. The assessment was based on the availability of existing standards, and information obtained from a field survey of operational systems, the literature, and discussions with individuals in the industry. Field inspections of 10 operational IPH systems were performed. Author (GRA)

**N82-24640\*** National Aeronautics and Space Administration. Langley Research Center, Hampton, Va.

**SOLAR ENGINE Patent**

R. N. JENSEN, inventor (to NASA) 27 Apr. 1981 6 p Filed 22 Jun. 1979 Supersedes N79-29608 (17 - 20, p 2692)

(NASA-CASE-LAR-12148-1; US-PATENT-4,326,381;

US-PATENT-APPL-SN-051275; US-PATENT-CLASS-60-641.14;

US-PATENT-CLASS-60-516) Avail: US Patent and Trademark Office CSCL 10B

A solar engine is disclosed in which a fluid, which is first heated and then cooled, forces a piston outward as the fluid is heated, and then draws the piston inward as the fluid is cooled. The piston is connected to a shaft and produces work as it moves outward and inward. A displacer plate moves between an absorber plate and a cooling plate to form an air space between the displacer and one or the other of these two plates for heating and cooling the fluid. The displacer plate is moved from one plate to the other by the displacer push ring as the piston nears the midpoint of its travel on the outward stroke and again on the inward stroke. Official Gazette of the US Patent and Trademark Office.

**N82-24646\*** # Jet Propulsion Lab., California Inst. of Tech., Pasadena.

**SUBSYSTEMS DESIGN AND COMPONENT DEVELOPMENT FOR THE PARABOLIC DISH MODULE FOR SOLAR THERMAL POWER SYSTEMS Annual Technical Report**

C. K. STEIN 15 Mar. 1982 30 p Prepared in cooperation with NASA. Lewis Research Center

(Contract NAS7-10; DE-AT04-81AL-16228)

(NASA-CR-168941; DOE/JPL-1060-51; JPL-PUB-82-22; NAS

1.26:168941) Avail: NTIS HC A03/MF A01 CSCL 10A

Solar thermal power systems parabolic dish activities are summarized. Subsystem designs of concentrators, receivers, engines, power converters, and thermal transport are discussed. Analyses, test results, field tests, small community system development and the parabolic dish test site are also included.

Author

**N82-24666** # Midwest Research Inst., Golden, Colo. Solar Energy Research Inst.

**AN OVERVIEW OF THE SERI SOLAR ENERGY STORAGE PROGRAM**

C. E. WYMAN In Courtesy Associates, Inc. Proc. of the DOE Thermal and Chem. Storage Ann. Contractor's Rev. Meeting p 47-49 Mar. 1981 refs

Avail: NTIS HC A16/MF A01

Thermal energy storage concepts and thermal energy transport by sensible and latent heat media are studied. Systems analyses are performed of thermal energy storage for solar thermal applications, and surveys and assessments are used to coordinate thermal energy storage activities for solar applications, particularly in building heating and cooling.

S.L.

**N82-24669** # Stearns-Roger Corp., Denver, Colo.

**COST AND PERFORMANCE OF THERMAL STORAGE CONCEPTS IN SOLAR THERMAL SYSTEMS**

A. W. MCKENZIE In Courtesy Associates, Inc. Proc. of the DOE Thermal and Chem. Storage Ann. Contractor's Rev. Meeting p 58-59 Mar. 1981

Avail: NTIS HC A16/MF A01

Studies to provide consistently calculated cost data, develop realistic performance data, and to project data for several thermal storage concepts integrated into several solar thermal systems are summarized. Available thermal storage concepts were reviewed through a literature search, contacts, and contractors. A screening criteria was developed and schematics were made for these systems. Rough-order-of-magnitude costs were determined and candidate systems were further reduced. The remaining twenty systems were more fully developed.

M.D.K.

**N82-24675** # Sandia Labs., Livermore, Calif.

**SOLAR THERMAL POWER STORAGE APPLICATIONS LEAD LABORATORY OVERVIEW**

L. G. RADOSEVICH In Courtesy Associates, Inc. Proc. of the DOE Thermal and Chem. Storage Ann. Contractor's Rev. Meeting p 84-88 Mar. 1981 Sponsored by DOE

Avail: NTIS HC A16/MF A01

An overview of activities for the applications elements of the Thermal Energy Storage for Solar Thermal Applications (TESSTA) program is presented. The TESSTA program which was initiated in FY80 is organized through a work breakdown structure which includes the development of thermal storage technologies matched to solar thermal power system requirements for several near-term applications. The status of the technology development activities ongoing in FY80 is presented here along with plans for FY81.

Author

**N82-24679** # State Univ. of New York, Buffalo. Dept. of Chemistry.

**CORROSION BEHAVIOR OF ALLOYS**

R. A. OSTERYOUNG and H. FERNANDEZ In Courtesy Associates, Inc. Proc. of the DOE Thermal and Chem. Storage Ann. Contractor's Rev. Meeting p 102-103 Mar. 1981 refs

Avail: NTIS HC A16/MF A01

Studies of molten nitrates at temperatures in the 450 - 550 C range were made to obtain information which will ultimately permit an understanding of the corrosion behavior of structural alloys, such as Incoloy 800, that will be employed in thermal loops in solar power systems. Initial activity will involve studies of species expected to exist in these melts from corrosion of structural alloys, i.e., iron, nickel and chromium.

Author

**N82-24692** # EIC, Inc., Newton, Mass.

**A CHEMICAL HEAT PUMP BASED ON THE REACTION OF CALCIUM CHLORIDE AND METHANOL FOR SOLAR HEATING, COOLING AND STORAGE**

P. O. OFFENHARTZ In Courtesy Associates, Inc. Proc. of the DOE Thermal and Chem. Storage Ann. Contractor's Rev. Meeting p 154-158 Mar. 1981 Sponsored by DOE. Prepared in cooperation with Sandia Lab., Livermore, Calif. and Brookhaven National Lab., Upton, N.Y.

Avail: NTIS HC A16/MF A01

An engineering development test prototype of the  $\text{CaCl}_2\text{-CheOH}$  chemical heat pump was tested. The unit, which has storage capacity in excess of 100,000 BTU, completed over 100 full charge-discharge cycles. Cycling data show that the rate of heat pumping depends strongly on the absorber-evaporator temperature difference. These rates are more than adequate for solar heating or for solar cooling using dry ambient air heat rejection. Performance degradation after 100 cycles, expressed as a contact resistance, was less than 2 C. The heat exchangers showed some warpage due to plastic flow of the salt, producing the contact resistance. The experimental COP for cooling was 0.52, close to the theoretically predicted value.

Author

**N82-24719\*** # Tracor MB Associates, San Ramon, Calif.

**PROCESS DEVELOPMENT FOR AUTOMATED SOLAR CELL AND MODULE PRODUCTION. TASK 4: AUTOMATED ARRAY ASSEMBLY Quarterly Report**

J. J. HAGERTY 15 Jan. 1981 42 p

(Contract JPL-955699)

(NASA-CR-168923; JPL-9950-475; DOE/JPL-955600-81/02; NAS 1.26:168923; MBR-81/01; QR-2) Avail: NTIS HC A03/MF A01 CSCL 10A

The cell preparation station was installed in its new enclosure. Operation verification tests were performed. The detailed layout drawings of the automated lamination station were produced and construction began. All major and most minor components were delivered by vendors. The station framework was built and assembly of components begun.

Author

**N82-24720\*** # General Electric Co., Cincinnati, Ohio. Advanced Energy Dept.

**A CONCEPTUAL DESIGN STUDY OF A HIGH TEMPERATURE SOLAR THERMAL RECEIVER Final Report**

C. S. ROBERTSON, C. L. EHDE, L. E. STACY, S. S. ABUJAWDEH, R. NARAYANAN, L. R. MCCREIGHT, A. GATTI, and H. W. RAUCH, SR. 4 Jan. 1980 160 p refs Prepared for JPL

(Contract JPL-955455)

(NASA-CR-168925; JPL-9950-483; NAS 1.26:168925; GEEP-66)

Avail: NTIS HC A08/MF A01 CSCL 10A

A conceptual design was made for a solar thermal receiver capable of operation in the 1095 to 1650 C (2000 to 3000 F) temperature range. This receiver is designed for use with a two-axis paraboloidal concentrator in the 25 to 150 kW sub t power range, and is intended for industrial process heat, Brayton engines, or chemical/fuels reactions. Three concepts were analyzed parametrically. One was selected for conceptual design. Its key feature is a helical coiled tube of sintered silicon nitride which serves as the heat exchanger between the incident solar radiation

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and the working fluid. A mechanical design of this concept was prepared, and both thermal and stress analysis performed. The analysis showed good performance, low potential cost in mass production, and adaptability to both Brayton cycle engines and chemical/fuels production. B.W.

**N82-24721\*#** Carnegie-Mellon Univ., Pittsburgh, Pa. Mechanical Engineering and Public Policy.

### **SAFETY AND LIABILITY CONSIDERATIONS FOR PHOTOVOLTAIC MODULES/PANELS**

A. S. WEINSTEIN and D. G. MEEKER Jan. 1981 56 p refs Prepared for JPL

(Contract JPL-955846)

(NASA-CR-168938; DOE/JPL-955846-81/1; NAS 1.26:168938)

Avail: NTIS HC A04/MF A01 CSCL 10A

An overview of legal issues as they apply to design, manufacture, and use is presented. A methodology to be used during design of a photovoltaic module/array to minimize or eliminate perceived hazards is suggested. T.M.

**N82-25111\*#** Jet Propulsion Lab., California Inst. of Tech., Pasadena.

### **A SIMPLIFIED SOLAR CELL ARRAY MODELLING PROGRAM**

R. D. HUGHES *In its* The Telecommun. and Data Acquisition Rept. p 167-185 15 Apr. 1982 refs

Avail: NTIS HC A09/MF A01 CSCL 10A

As part of the energy conversion/self sufficiency efforts of DSN engineering, it was necessary to have a simplified computer model of a solar photovoltaic (PV) system. This article describes the analysis and simplifications employed in the development of a PV cell array computer model. The analysis of the incident solar radiation, steady state cell temperature and the current-voltage characteristics of a cell array are discussed. A sample cell array was modelled and the results are presented. S.L.

**N82-25296\*#** Jet Propulsion Lab., California Inst. of Tech., Pasadena.

### **OPTICAL CHARACTERIZATION OF SOLAR CONCENTRATOR MIRRORS USING THE SOLAR BEAM OF THE JPL 25-FOOT SPACE SIMULATOR**

M. J. ARGOUD and E. W. DENNISON *In* NASA. Goddard Space Flight Center 12th Space Simulation Conf. 19 p 1982

Avail: NTIS HC A15/MF A01 CSCL 22B

The Jet Propulsion Laboratory 25-foot space simulator with its 5.8-m (19-ft) diameter simulated solar beam provides an excellent facility for measuring the optical characteristics of parabolic solar concentrator panels and gores. The virtual source position and size were determined by using a single lamp of the 37 xenon 30-kW source array with only the center lens in the 19-channel optical mixer. This data was used to define the optical test geometry, and it allowed accurate measurement of focal length and surface deviations of the mirror under test. A flux distribution of a typical solar concentrator placed directly on the solar beam gives measurements of performance at the focal point of the parabolic surface. Author

**N82-25409#** Mid-American Solar Energy Complex, Minneapolis, Minn.

### **EVALUATION FOR FY 1981 OF MASEC'S RETROFIT RESIDENTIAL SINGLE-FAMILY DWELLINGS PASSIVE SOLAR HEATING PROJECT**

Sep. 1981 6 p refs

(Contract DE-AC02-79CS-30150)

(DE82-001188; MASEC-R-81-031; P-102-5) Avail: NTIS HC A02/MF A01

The utilization of energy conserving techniques with passive and hybrid solar heating in the retrofit single family housing market is investigated. Processes were developed that result in a 50 percent reduction in space heating energy use for 25 percent of all existing single family housing. DOE

**N82-25412#** Mid-American Solar Energy Complex, Minneapolis, Minn.

### **DESCRIPTION OF FIVE HOUSES INSTRUMENTED FOR CLASS B ANALYSIS**

Aug. 1981 23 p

(Contract DE-AC02-79CS-30150)

(DE82-001186; MASEC-R-81-015; P-101-3) Avail: NTIS HC

A02/MF A01

The five houses to be monitored are described along with the instrumentation. Floor plans are shown. The progress of the equipment procurement, installation, and the monitoring itself is summarized. DOE

**N82-25638\*#** Jet Propulsion Lab., California Inst. of Tech., Pasadena.

### **FSA FIELD TEST Annual Report, Aug. 1980 - Aug. 1981**

P. JAFFE, R. W. WEAVER, and R. E. LEE 15 Dec. 1981 49 p

(Contract NAS7-100; DE-AI01-76ET-20356)

(NASA-CR-168991; DOE/JPL-1012-59; JPL-PUB-81-99; NAS

1.26:168991) Avail: NTIS HC A03/MF A01 CSCL 10A

The 12 continental remote sites were decommissioned. Testing was consolidated into a five-site network consisting of the four Southern California sites and a new Florida site. 16 kW of new state-of-the-art modules were deployed at the five sites. Testing of the old modules continued at the Goldstone site but as a low-priority item. Array testing of modules is considered. Additional new testing capabilities were added. A battery-powered array data logger is discussed. A final set of failure and degradation data was obtained from the modules. Author

**N82-25639\*#** Jet Propulsion Lab., California Inst. of Tech., Pasadena.

### **DISH CONCENTRATORS FOR SOLAR THERMAL ENERGY: STATUS AND TECHNOLOGY DEVELOPMENT**

L. D. JAFFE 1 Jan. 1982 69 p refs Presented at the 2nd Terrestrial Energy Systems Conf., Colorado Springs, 1-3 Dec. 1981

(Contract NAS7-100; DE-AT04-81AL-16228)

(NAS 1.26:168994) Avail: NTIS HC A04/MF A01 CSCL 10A

Point-focusing concentrators under consideration for solar thermal energy use are reviewed. These concentrators differ in such characteristics as optical configuration, optical materials, structure for support of the optical elements and of the receiver, mount, foundation, drive, controls and enclosure. Concentrator performance and cost are considered. Technology development is outlined, including wind loads and aerodynamics; precipitation, sand, and seismic considerations; and maintenance and cleaning. Author

**N82-25641\*#** National Aeronautics and Space Administration. Langley Research Center, Hampton, Va.

### **THERMAL PERFORMANCE OF A PHOTOGRAPHIC LABORATORY PROCESS: SOLAR HOT WATER SYSTEM**

J. A. WALKER and R. N. JENSEN Apr. 1982 22 p

(NASA-TM-83299; NAS 1.15:83299) Avail: NTIS HC A02/MF

A01 CSCL 10A

The thermal performance of a solar process hot water system is described. The system was designed to supply 22,000 liters (5,500 gallons) per day of 66 C (150 F) process water for photographic processing. The 328 sq m (3,528 sq. ft.) solar field has supplied 58% of the thermal energy for the system. Techniques used for analyzing various thermal values are given. Load and performance factors and the resulting solar contribution are discussed. S.L.

**N82-25642\*#** National Aeronautics and Space Administration. Marshall Space Flight Center, Huntsville, Ala.  
**SATELLITE POWER SYSTEM. CONCEPT DEVELOPMENT AND EVALUATION PROGRAM. VOLUME 4: ENERGY CONVERSION AND POWER MANAGEMENT**  
 Nov. 1981 366 p refs  
 (NASA-TM-58237; NAS 1.15:58237) Avail: NTIS HC A16/MF A01 CSCL 10A

Analyses performed for the satellite power system (SPS) reference system concept are presented. The reference concept together with descriptions of energy conversion, power distribution, and power management for solar photovoltaics, solar thermal, and concept comparisons are reviewed. Studies on energy conversion and power management (environmental impacts, annealing, nuclear SPS concept, and thermionic) are also reported. E.A.K.

**N82-25646#** Mid-American Solar Energy Complex, Minneapolis, Minn.

**PASSIVE SOLAR CLASS B MONITORING REPORTS**

Sep. 1981 35 p refs  
 (Contract DE-AC02-79CS-30150)  
 (DE82-003139; MASEC-R-81-016) Avail: NTIS HC A03/MF A01

A program for monitoring the performance of passive solar houses is briefly described relevant to the monthly monitoring reports. Equipment was installed in 3 houses, two in Iowa and one in Wisconsin. The required contents of the monthly reports are outlined, and monthly reports are included from one Iowa and one Wisconsin site. Information includes a site summary sheet elevation and floor plan sketches, weather summary, daily data printout and thermal comfort. DOE

**N82-25647#** Mid-American Solar Energy Complex, Minneapolis, Minn.

**EVALUATION FOR FY 1981 OF MASEC'S NEW RESIDENTIAL MULTI-FAMILY DWELLING PASSIVE SOLAR HEATING PROJECT**

Sep. 1981 6 p refs  
 (Contract DE-AC02-70CS-30150)  
 (DE82-001206; MASEC-R-81-037; P-103-6) Avail: NTIS HC A02/MF A01

The program to form teams to design and build one passive solar building is discussed. Documentation of the process and the conducting of workshops on its design, construction, and marketing is described. DOE

**N82-25648#** Mid-American Solar Energy Complex, Minneapolis, Minn.

**QUARTERLY REPORT OF SOLAR FEDERAL BUILDINGS: PROGRAM IN THE MASEC REGION**

Sep. 1981 26 p  
 (Contract DE-AC02-79CS-30150)  
 (DE82-001185; MASEC-R-81-059/2; A-104-6) Avail: NTIS HC A03/MF A01

Activities concerning the short course on solar and energy conservation for buildings are reviewed. DOE

**N82-25649#** Mid-American Solar Energy Complex, Minneapolis, Minn.

**EVALUATION OF THE SOLAR CITIES PROGRAM**

J. MUSUMECI Sep. 1981 10 p  
 (Contract DE-AC02-79CS-30150)  
 (DE81-030868; MASEC-R-81-044) Avail: NTIS HC A02/MF A01

The Grand Island Social Services Project, the Solar Utilities Conference, and Model Codes Workshops, and support services provided under this work package are described. Author

**N82-25651#** Mid-American Solar Energy Complex, Minneapolis, Minn.

**SUMMARY OF COMMERCIAL DEMONSTRATION PROJECTS**

Sep. 1981 44 p  
 (Contract DE-AC02-79CS-30150)  
 (DE82-002278; MASEC-PA-81-055) Avail: NTIS HC A03/MF A01

Problem areas and successes of eighteen solar energy demonstration project sites are summarized. The design and construction phase is discussed first and then the components where problems occurred during operation are discussed. DOE

**N82-25653#** Mid-American Solar Energy Complex, Minneapolis, Minn.

**ANALYSIS OF THE SOLAR 80 PROGRAM IN FISCAL YEAR 1981**

Sep. 1981 14 p  
 (Contract DE-AC02-79CS-30150)  
 (DE82-001190; MASEC-R-81-017) Avail: NTIS HC A02/MF A01

The Solar 80 Program is discussed in general. A review of existing solar houses is presented and the MASEC Solar 80 house design process is described. An evaluation of the Solar 80 program and products is also presented. DOE

**N82-25654#** Los Alamos Scientific Lab., N. Mex.

**SOLAR ENERGY RESEARCH AT LOS ALAMOS Progress Report, 1 Oct. - 31 Dec. 1980**

S. K. REISFELD, comp. and D. A. NEEPER, comp. Sep. 1981 55 p

(Contract W-7405-ENG-36)  
 (DE82-004222; LA-8984-PR) Avail: NTIS HC A04/MF A01

The performance of so-called sun-tempered buildings is under investigation. The thermal effects of water transpiration in the greenhouse of the Balcomb house are reported. The convective loop experiment shows that collector efficiency is nearly independent of the depth of the flow channels in the collector. Corrosion in liquid-cooled systems is being studied. Numerical modeling to investigate various methods for solar drying of sewage sludge, the existence of a boundary layer at the interface between the convecting and nonconvecting regions of a solar pond are discussed. Numerical analysis indicates that the convecting region will encroach upon the nonconvecting region when the temperature difference across the nonconvecting region exceeds a critical value. DOE

**N82-25656#** Messerschmitt-Boelkow-Blohm G.m.b.H., Ottobrunn (West Germany). Unternehmensbereich Raumfahrt.

**PILOT SOLAR POWER PLANT [PILOT-SOLARKRAFTANLAGE]**  
 D. WOLF 1981 4 p Repr. from Erdoel u. Kohle - Erdgas - Petrochem. vereinigt mit Brennstoff-chem., v. 33, no. 8, Aug. 1980 p 343-344 In GERMAN

(MBB-UR-533-81-O) Avail: Issuing Activity

A fully functionally efficient solar-thermal power plant (10 kW electric) was built. The operating principle of thermomechanical conversion of solar energy into mechanical or electrical energy is presented. The equipment is completely automatic. Flat plate collectors absorb solar energy and convert it into heat which is transmitted by water to a heat exchanger. A closed cycle machine uses the heat to boil a working fluid (C2C12F4). A screw, powered by gas expansion in the working fluid, converts mechanical energy into electrical energy. Author (ESA)

**N82-26458#** Telic Corp., Santa Monica, Calif.

**INVESTIGATION OF CONTINUOUS DEPOSITION OF AMA-TYPE COATINGS ONTO STRIP AND SHEET BY SPUTTERING Semiannual Technical Progress Report, 5 Sep. 1980 - 30 Nov. 1981**

J. A. THORNTON and J. L. LAMB 1 Dec. 1981 62 p refs  
 (Contract DE-AC04-80AL-13116)  
 (DE82-004266; DOE/AL-13116/T1; TELIC-81-3) Avail: NTIS HC A04/MF A01

The continuous deposition of multilayer selective absorber coatings onto strip by planar magnetron sputtering was investigated.

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Metal-layer materials other than Mo that might provide improved thermal stability in air were also examined. Cr, Mo, Ni, Ta, and a Pt/Al<sub>2</sub>O<sub>3</sub> cermet were considered for use as the intermediate metal layer. In each case the same metal was also used for the low emittance base layer. The substrates were glass and stainless steel plates. Good spectral selectivity and emittance at 200 C of 0.10, was achieved on glass substrates for all of the materials. The thermal stabilities of the coatings confirm the earlier work and underscore the importance of the Al<sub>2</sub>O<sub>3</sub> layer. Coatings on glass substrates with rf sputtered Al<sub>2</sub>O<sub>3</sub> layers were stable in air to 500 to 6000 C and in vacuum to at least 650 to 7000 C; they appear attractive for medium and high temperature collectors. The Mo and Ni-based coatings with reactive sputtering Al<sub>2</sub>O<sub>3</sub> were stable during 1000 hr-long tests in air at 3500 C and show promise as low cost coatings for low temperature flat plate collector applications. DOE

**N82-26514#** Lincoln Lab., Mass. Inst. of Tech., Lexington.  
**DATA REPORT FOR THE NORTHEAST RESIDENTIAL EXPERIMENT STATION, SEPTEMBER 1981**  
M. C. RUSSELL, P. RAGHURAMAN, and P. C. MAHONEY Oct. 1981 13 p  
(Contract DE-AC02-76ET-20279)  
(DE82-005616; DOE/ET-20279/165) Avail: NTIS HC A02/MF A01

The residential experiment stations were designed to develop residential photovoltaic systems and to gather and disseminate performance data for the photovoltaic community, cognizant institutions and, ultimately, the public. Physical performance data obtained from photovoltaic energy systems are tabulated. DOE

**N82-26699#** Midwest Research Inst., Golden, Colo. Solar Energy Research Inst.  
**QUALITY ASSURANCE AND STANDARDS PLAN FOR SOLAR THERMAL TECHNOLOGIES**  
H. R. W. COBB Jul. 1981 34 p refs  
(Contract DE-AC02-77CH-00178)  
(DE81-030831; SERI/RR-742-846) Avail: NTIS HC A03/MF A01

The development of a quality assurance and standards (QA and S) plan for the photovoltaic (PV) and domestic solar heating (SHAC) technologies preceded that for solar thermal technologies, permitting a review and lessons-learned approach to developing a solar thermal QA and S plan. It is noted that the state of the art for solar thermal technology is not as complicated or novel as PV and is better suited to engineering dialogues for input and implementation than SHAC. It is important to recognize the differences in legislative directives that influence the US Department of Energy's approach to the process of developing a QA and S plan. Specific legislative directives to develop criteria for PV and SHAC are replaced for solar thermal with directives to develop standards using a commercial approach. Accordingly, a series of standards matrices are proposed as the keystone to the plan which will identify the functions of components, subsystems and systems. DOE

**N82-26776\*** National Aeronautics and Space Administration. Pasadena Office, Calif.  
**AUTOMOTIVE ABSORPTION AIR CONDITIONER UTILIZING SOLAR AND MOTOR WASTE HEAT Patent**  
Z. POPINSKI, inventor (to NASA) (JPL, California Inst. of Tech., Pasadena) 29 Dec. 1981 6 p Filed 30 Jul. 1980 Supersedes N80-29843 (18 - 20, p 2726) Sponsored by NASA  
(NASA-CASE-NPO-15183-1; US-PATENT-4,307,575;  
US-PATENT-APPL-SN-173519; US-PATENT-CLASS-62-148;  
US-PATENT-CLASS-62-235.1; US-PATENT-CLASS-62-238.3;  
US-PATENT-CLASS-62-239; US-PATENT-CLASS-62-244;  
US-PATENT-CLASS-62-476) Avail: US Patent and Trademark Office CSCL 10A

In combination with the ground vehicles powered by a waste heat generating electric motor, a cooling system including a generator for driving off refrigerant vapor from a strong refrigerant absorbant solution is described. A solar collector, an air-cooled

condenser connected with the generator for converting the refrigerant vapor to its liquid state, an air cooled evaporator connected with the condenser for returning the liquid refrigerant to its vapor state, and an absorber is connected to the generator and to the evaporator for dissolving the refrigerant vapor in the weak refrigerant absorbant solution, for providing a strong refrigerant solution. A pump is used to establish a pressurized flow of strong refrigerant absorbant solution from the absorber through the electric motor, and to the collector.

Official Gazette of the U.S. Patent and Trademark Office

**N82-26777\*** National Aeronautics and Space Administration. Pasadena Office, Calif.  
**EFFICIENCY OF SILICON SOLAR CELLS CONTAINING CHROMIUM Patent**  
A. M. SALAMA, inventor (to NASA) (JPL, California Inst. of Tech., Pasadena) 19 Jan. 1982 8 p Filed 11 Sep. 1980 Supersedes N80-32850 (18 - 23, p 3156) Sponsored by NASA  
(NASA-CASE-NPO-15179-1; US-PATENT-4,311,870;  
US-PATENT-APPL-SN-185867; US-PATENT-CLASS-136-261;  
US-PATENT-CLASS-136-290; US-PATENT-CLASS-148-1.5;  
US-PATENT-CLASS-357-30; US-PATENT-CLASS-357-63;  
US-PATENT-CLASS-219-121LN) Avail: US Patent and Trademark Office CSCL 10A

Efficiency of silicon solar cells containing about one quadrillion atoms cu cm of chromium is improved about 26% by thermal annealing of the silicon wafer at a temperature of 200 C to form chromium precipitates having a diameter of less than 1 Angstrom. Further improvement in efficiency is achieved by scribing laser lines onto the back surface of the wafer at a spacing of at least 0.5 mm and at a depth of less than 13 micrometers to preferentially precipitate chromium near the back surface and away from the junction region of the device. This provides an economical way to improve the deleterious effects of chromium, one of the impurities present in metallurgical grade silicon material.

Official Gazette of the U.S. Patent and Trademark Office

**N82-26785\*#** Science Applications, Inc., Golden, Colo.  
**AN OVERVIEW OF THE VALUE OF PARABOLIC DISH SOLAR THERMAL SYSTEMS IN INDUSTRIAL COGENERATION APPLICATIONS**  
Mar. 1982 152 p Prepared for JPL, Pasadena, Calif.  
(Contract JPL-955908)  
(NASA-CR-169063; NAS.1.26:169063) Avail: NTIS HC A08/MF A01 CSCL 10A

The essential elements of the cogeneration system configuration to be captured were the displacement of thermal energy by collection and use of the Brayton exhaust stream, and the sale back to the utility of any electricity production in excess of on-site requirements. In contrast to simply dumping these energy flows, their use or sale obviously serves, by itself, to increase gross value of the solar thermal energy system. Net allowable cost of the parabolic dish modules may or may not be increased, however. A consideration is that the waste heat capture and delivery subsystems are not free. This study does not address the incremental cost of adding waste heat capture, transport, and conversion (to steam, if necessary). It does compute a value for the thermal energy thereby displaced. This value can serve as a first-round input to any detailed economic evaluation of waste heat recovery. T.M.

**N82-26786\*#** General Electric Co., Philadelphia, Pa. Advanced Energy Programs Dept.  
**INTEGRATED RESIDENTIAL PHOTOVOLTAIC ARRAY DEVELOPMENT Final Report**  
N. F. SHEPARD, JR. 11 Dec. 1981 155 p Sponsored in part by DOE  
(Contract JPL-955894)  
(NASA-CR-169042; DOE/JPL-955894-5; JPL-9950-660; NAS.1.26:169042) Avail: NTIS HC A08/MF A01 CSCL 10A

An advanced, universally-mountable, integrated residential photovoltaic array concept was defined based upon an in-depth formulation and evaluation of three candidate approaches which

were synthesized from existing or proposed residential array concepts. The impact of module circuitry and process sequence is considered and technology gaps and performance drivers associated with residential photovoltaic array concepts are identified. The actual learning experience gained from the comparison of the problem areas of the hexagonal shingle design with the rectangular module design led to what is considered an advanced array concept. Building the laboratory mockup provided actual experience and the opportunity to uncover additional technology gaps. Author

**N82-26787\*#** Boeing Engineering and Construction, Seattle, Wash.

**AIR BRAYTON SOLAR RECEIVER, PHASE 1 Final Report**

D. K. ZIMMERMAN 5 Jan. 1979 110 p Prepared for JPL

(Contract JPL-955119)

(NASA-CR-169081; NAS 1.26:169081) Avail: NTIS HC A06/MF A01 CSCL 10A

A six month analysis and conceptual design study of an open cycle Air Brayton Solar Receiver (ABSR) for use on a tracking, parabolic solar concentrator are discussed. The ABSR, which includes a buffer storage system, is designed to provide inlet air to a power conversion unit. Parametric analyses, conceptual design, interface requirements, and production cost estimates are described. The design features were optimized to yield a zero maintenance, low cost, high efficiency concept that will provide a 30 year operational life. Author

**N82-26793\*#** Westinghouse Research and Development Center, Pittsburgh, Pa.

**SILICON DENDRITIC WEB MATERIAL Final Report**

D. L. MEIER, R. B. CAMPBELL, L. J. SIENKIEWICZ, and P. RAI-CHOUDHURY Mar. 1982 88 p refs Sponsored in part by DOE

(Contract JPL-955624)

(NASA-CR-169053; DOE/JPL-955624-82/3; JPL-9950-684; NAS 1.26:169053) Avail: NTIS HC A05/MF A01 CSCL 10A

The development of a low cost and reliable contact system for solar cells and the fabrication of several solar cell modules using ultrasonic bonding for the interconnection of cells and ethylene vinyl acetate as the potting material for module encapsulation are examined. The cells in the modules were made from dendritic web silicon. To reduce cost, the electroplated layer of silver was replaced with an electroplated layer of copper. The modules that were fabricated used the evaporated Ti, Pd, Ag and electroplated Cu (TiPdAg/Cu) system. Adherence of Ni to Si is improved if a nickel silicide can be formed by heat treatment. The effectiveness of Ni as a diffusion barrier to Cu and the ease with which nickel silicide is formed is discussed. The fabrication of three modules using dendritic web silicon and employing ultrasonic bonding for interconnecting cells and ethylene vinyl acetate as the potting material is examined. E.A.K.

**N82-26794\*#** Solarex Corp., Rockville, Md.

**PROCESS RESEARCH ON SEMIX SILICON MATERIALS (PROSSM) Quarterly Report, 1 Dec. 1981 - 28 Feb. 1982**

J. H. WOHLGEMUTH and D. B. WARFIELD 28 Feb. 1982 28 p refs Sponsored in cooperation with DOE Prepared for JPL, Pasadena, Calif.

(Contract JPL-955902)

(NASA-CR-169049; DOE/JPL-955902-5; JPL-9950-683; NAS 1.26:169049; QR-5) Avail: NTIS HC A03/MF A01 CSCL 10A

A cost effective process sequence was identified, equipment was designed to implement a 6.6 MW per year automated production line, and a cost analysis projected a \$0.56 per watt cell add-on cost for this line. Four process steps were developed for this program: glass beads back clean-up, hot spray antireflective coating, wave soldering of fronts, and ion milling for edging. While spray dopants were advertised as an off the shelf developed product, they were unreliable with shorter than advertised shelf life. S.L.

**N82-26795\*#** ARCO Solar, Inc., Chatsworth, Calif. Module Design Dept.

**DESIGN, FABRICATION AND TEST OF BLOCK 4 DESIGN SOLAR CELL MODULES. PART 2: RESIDENTIAL MODULE Final Report**

T. L. JESTER Apr. 1982 36 p Sponsored in part by DOE

(Contract JPL-955403)

(NASA-CR-169158; NAS 1.26:169158; DOE/JPL-955402-82/12; JPL-9950-682) Avail: NTIS HC A03/MF A01 CSCL 10A

Design, fabrication and test of the Block IV residential load module are reported. Design changes from the proposed module design through three iterations to the discontinuance of testing are outlined. Author

**N82-26796\*#** Westinghouse Research and Development Center, Pittsburgh, Pa.

**LARGE-AREA SHEET TASK ADVANCED DENDRITIC WEB GROWTH DEVELOPMENT Annual Report, 23 Oct. 1980 - Oct. 1981**

C. S. DUNCAN, R. G. SEIDENSTICKER, J. P. MCHUGH, R. H. HOPKINS, D. L. MEIER, and J. SCHRUBEN 2 Mar. 1982 89 p refs Sponsored in part by DOE Prepared for JPL, Pasadena, Calif.

(Contract JPL-955843)

(NASA-CR-169047; DOE/JPL-955843-82/1; NAS 1.26:169047)

Avail: NTIS HC A05/MF A01 CSCL 10A

Thermal models were developed that accurately predict the thermally generated stresses in the web crystal which, if too high, cause the crystal to degenerate. The application of the modeling results to the design of low-stress experimental growth configurations will allow the growth of wider web crystals at higher growth velocities. A new experimental web growth machine was constructed. This facility includes all the features necessary for carrying out growth experiments under steady thermal conditions. Programmed growth initiation was developed to give reproducible crystal starts. Width control permits the growth of long ribbons at constant width. Melt level is controlled to 0.1 mm or better. Thus, the capability exists to grow long web crystals of constant width and thickness with little operator intervention, and web growth experiments can now be performed with growth variables controlled to a degree not previously possible. T.M.

**N82-26797\*#** Photowatt International, Inc., Tempe, Ariz.

**DEVELOPMENT OF TECHNIQUE FOR AR COATING AND NICKEL AND COPPER METALLIZATION OF SOLAR CELLS. FPS PROJECT: PRODUCT DEVELOPMENT Quarterly Technical Report, 1 Oct. 1981 - 31 Mar. 1982**

W. TAYLOR 15 Apr. 1982 16 p Sponsored in part by DOE

(Contract JPL-955986)

(NASA-CR-169055; DOE/JPL-955986-2; JPL-9950-673; NAS 1.26:169055; QTR-2; QTR-3) Avail: NTIS HC A02/MF A01 CSCL 10A

Printed nickel overplated with copper and applied on top of a predeposited silicon nitride antireflective coating system for metallizing solar cells was analyzed. The ESL D and E paste formulations, and the new formulations F, G, H, and D-1 were evaluated. The nickel thick films were tested after firing for stability in the cleaning and plating solutions used in the Vanguard-Pacific brush plating process. It was found that the films are very sensitive to the leaning and alkaline copper solutions. Less sensitivity was displayed to the neutral copper solution. Microscopic and SEM observations show segregation of frit at the silicon nitride thick film interface with loose frit residues after lifting off plated grid lines. E.A.K.

## 02 SOLAR ENERGY

**N82-26800\*#** General Electric Co., Philadelphia, Pa. Advanced Energy Programs Dept.

**EFFECTS OF SYSTEM FACTORS ON THE ECONOMICS OF AND DEMAND FOR SMALL SOLAR THERMAL POWER SYSTEMS Final Report, Dec. 1978 - Mar. 1980**

Sep. 1981 198 p refs Sponsored in part by DOE Prepared for JPL, Pasadena

(Contract JPL-955273)

(NASA-CR-169043; DOE/JPL-955273-1; NAS 1.26:169043)

Avail: NTIS HC A09/MF A01 CSCL 10A

Market penetration as a function time, SPS performance factors, and market/economic considerations was estimated, and commercialization strategies were formulated. A market analysis task included personal interviews and supplemental mail surveys to acquire statistical data and to identify and measure attitudes, reactions and intentions of prospective SPS users. Interviews encompassed three ownership classes of electric utilities and industrial firms in the SIC codes for energy consumption. A market demand model was developed which utilized the data base developed, and projected energy price and consumption data to perform sensitivity analyses and estimate potential market for SPS.

S.L.

**N82-26801\*#** Applied Concepts Corp., Reston, Va.

**USAF SOLAR THERMAL APPLICATIONS CASE STUDIES**

18 Sep. 1981 65 p

(Contract JPL-955887)

(NASA-CR-169054; JPL-9950-669; NAS 1.26:169054;

TR-J01-02-81) Avail: NTIS HC A04/MF A01 CSCL 10A

The potential of solar energy technologies to meet mission related applications for process heat was investigated. The reduction of the dependence of military installations on fossil fuels by promoting the use of more abundant resources where liquid hydrocarbons and natural gas are now used is examined. The evaluation and utilization of renewable energy systems to provide process heat and space heating are emphasized. The application of thermal energy systems is divided into four steps: (1) investigation of the potential operational cost effectiveness of selected thermal technologies; (2) selection of a site and preliminary design of point focussing solar thermal plant; (3) construction and test of an engineering prototype; and (4) installation and operation of a solar thermal energy plant.

E.A.K.

**N82-26802\*#** RCA Labs., Princeton, N. J.

**EVALUATION AND VERIFICATION OF EPITAXIAL PROCESS SEQUENCE FOR SILICON SOLAR-CELL PRODUCTION Final Program Summary Report**

D. REDFIELD Nov. 1981 25 p refs Sponsored in part by DOE Prepared for JPL, Pasadena, Calif.

(Contract NAS7-100; JPL-955825)

(NASA-CR-169044; DOE/JPL-955825-81/3; NAS 1.26:169044)

Avail: NTIS HC A02/MF A01 CSCL 10A

To achieve the program goals, 28 minimodules were fabricated and tested, using 600 cells made from three-inch-diameter wafers processed by the sequence chosen for this purpose. Of these 600 cells, half were made from epitaxially grown layers on potentially low-cost substrates. The other half were made from commercial semiconductor-grade (SG), single-crystal silicon wafers that served as controls. Cell processing was normally performed on mixed lots containing significant numbers of each of these two types of wafers. After evaluation of the performance of all cells, they were separated by types for incorporation into modules that were to be tested for electrical performance and response to environmental stress. A simplified flow chart displaying this scheme, for quantities representing half of the planned total to be processed, is presented.

T.M.

**N82-26805\*#** Westinghouse Research and Development Center, Pittsburgh, Pa.

**SILICON WEB PROCESS DEVELOPMENT Final Report**

C. S. DUNCAN, R. G. SEIDENSTICKER, J. P. MCHUGH, M. E. SKUTCH, J. M. DRIGGERS, and R. H. HOPKINS Oct. 1981 159 p refs Sponsored in part by DOE

(Contract JPL-954654)

(NASA-CR-169050; NAS 1.26:169050; DOE/JPL-954654-80/13;

JPL-9950-653) Avail: NTIS HC A08/MF A01 CSCL 10A

The silicon web process takes advantage of natural crystallographic stabilizing forces to grow long, thin single crystal ribbons directly from liquid silicon. The ribbon, or web, is formed by the solidification of a liquid film supported by surface tension between two silicon filaments, called dendrites, which border the edges of the growing strip. The ribbon can be propagated indefinitely by replenishing the liquid silicon as it is transformed to crystal. The dendritic web process has several advantages for achieving low cost, high efficiency solar cells. These advantages are discussed.

T.M.

**N82-26806\*#** Westinghouse Research and Development Center, Pittsburgh, Pa.

**SILICON MATERIALS TASK OF THE LOW COST SOLAR ARRAY PROJECT: EFFECT OF IMPURITIES AND PROCESSING ON SILICON SOLAR CELLS Final Report**

R. H. HOPKINS, J. R. DAVIS, A. ROHATGI, M. H. HANES, P. RAI-CHOUDHURY, and H. C. MOLLENKOPF (Hemlock Semiconductor Corp.) Feb. 1982 239 p refs Sponsored in part by DOE

(Contract JPL-954331)

(NASA-CR-169051; DOE/JPL-954331-82/13; JPL-9950-655; NAS

1.26:169051) Avail: NTIS HC A11/MF A01 CSCL 10A

The effects of impurities and processing on the characteristics of silicon and terrestrial silicon solar cells were defined in order to develop cost benefit relationships for the use of cheaper, less pure solar grades of silicon. The amount of concentrations of commonly encountered impurities that can be tolerated in typical p or n base solar cells was established, then a preliminary analytical model from which the cell performance could be projected depending on the kinds and amounts of contaminants in the silicon base material was developed. The impurity data base was expanded to include construction materials, and the impurity performance model was refined to account for additional effects such as base resistivity, grain boundary interactions, thermal processing, synergic behavior, and nonuniform impurity distributions. A preliminary assessment of long term (aging) behavior of impurities was also undertaken.

S.L.

**N82-26810#** Westinghouse Research and Development Center, Pittsburgh, Pa.

**RIBBON GROWTH OF SINGLE CRYSTAL GAAS FOR SOLAR CELL APPLICATION Final Report, 15 Aug. 1978 - 15 Aug. 1981**

T. A. GOULD, R. G. SEIDENSTICKER, and R. MAZELSKY Wright-Patterson AFB, Ohio AFWAL Nov. 1981 77 p refs

(Contract F33615-78-C-2031; AF PROJ. 3145)

(AD-A112038; REPT-81-9F4-GARSH-R1; AFWAL-TR-81-2115)

Avail: NTIS HC A05/MF A01 CSCL 20B

This report describes the results of a 3-year effort to develop GaAs dendritic web for high-efficiency solar cells. A unique GaAs ribbon growth system was developed by applying dendritic-web growth techniques to a liquid-encapsulated GaAs system. Computerized thermal modelling and experimental modification produced a thermal geometry from which 48 GaAs webs were grown. These crystals had a multidendrite and/or faceted morphology rather than typical web morphology. Crystal quality improved as thermal geometry, growth techniques, dendrite seeds, and melt chemistry were optimized during the course of the program; however, conventional web morphology was not achieved. Analyses of chemical modification, crystal-growth characteristics, and orientation relationships suggest that inherent materials properties of GaAs produce a typical web morphology under conventional web-growth conditions. Consequently, a simple

transfer of Si web growth technology to our GaAs system was inadequate for the growth of high quality GaAs web. GRA

**N82-26811#** Coast Guard Research and Development Center, Groton, Conn.

**LEAD-ACID BATTERIES IN SOLAR PHOTOVOLTAIC POWER SYSTEMS FOR MARINE AIDS TO NAVIGATION Final Report**

S. E. TRENCHARD Oct. 1981 32 p refs  
(AD-A112151; CGR/DC-29/81; USCG-D-04-82) Avail: NTIS HC A03/MF A01 CSCL 10C

Since 1974, the U.S. Coast Guard has been testing lead-acid batteries in solar photovoltaic-powered systems for aids to navigation. Three types of lead-acid batteries, distinguished by the composition of their grid material, have been tested: lead-antimony grid, lead-calcium grid, and pure-lead grid. This report contains a comparison of the charging characteristics and the charge-discharge cycling behavior of each grid type. All types were remarkably similar qualitatively in their daily as well as annual cycling behavior but the significance of the quantitative differences offer distinctive tradeoffs. This report presents models for water usage, depth-of-discharge, and post-cycle capacity for various levels of voltage regulation. Based on the post-cycle capacity tests, the effect of grid strength, grid thickness, and operating conditions on life expectancy are presented. A final discussion presents the results of a field deployment of solar photovoltaic-powered aids to navigation in the Miami, Florida area. Potential solutions to the battery terminal corrosion and bird guano problems observed are discussed. Author (GRA)

**N82-26814#** Automation Industries, Inc., Silver Spring, Md.  
**SOLAR-ENERGY-SYSTEM PERFORMANCE EVALUATION, GENERAL ELECTRIC - MILWAUKEE OPERATIONAL TEST SITE, MILWAUKEE, WISCONSIN, SEPTEMBER 1980 - MARCH 1981**

R. G. HOWARD 1981 87 p refs  
(Contract DE-AC01-79CS-30027)  
(DE82-001934; SOLAR/2097-81/14) Avail: NTIS HC A05/MF A01

The active solar energy system for a recreation hall for senior citizens in Wisconsin, is equipped with 1290 square feet of evacuated tube collectors, 3000 gallons of water in a tank, and a natural gas fired furnace for auxiliary space heating and a natural gas fired domestic water heater. The solar fraction, solar savings ratio, conventional fuel savings, system performance factor, and solar system coefficient of performance are given as well as performance data for the collector, storage, domestic hot water, and space heating subsystems, operating energy, energy savings, and weather conditions. Predicted performance data are also given for comparison with the measured data. DOE

**N82-26815#** Midwest Research Inst., Golden, Colo.  
**CALCULATED EFFECTS OF TEMPERATURE, INTENSITY AND ATMOSPHERIC CONDITIONS ON THE THERMODYNAMIC LIMITS FOR CONVERSION OF SOLAR ENERGY TO WORK ON STORED ENERGY**

M. L. BUHL, JR., R. E. BIRD, R. V. BILCHAK, J. S. CONNOLLY, and J. R. BOLTON Aug. 1981 11 p refs  
(Contract DE-AC02-77CH-00178)  
(DE81-030876; SERI/TP-233-1382) Avail: NTIS HC A02/MF A01

AM1.15 spectra are used to determine thermodynamic limits on photochemical or photovoltaic conversion with emphasis primarily on the effects of variation of atmospheric conditions on the efficiencies. The conditions examined are: absorber temperature, total solar intensity, air mass, ozone and water-zone content of the atmosphere, and the turbidity and visibility of the atmosphere. In addition efficiencies are computed for the diffuse component of global radiation as an approximation to cloudy conditions. The results are displayed as plots of solar conversion efficiency vs. bandgap wavelength for each set of conditions. Conclusions are then drawn as to the important variants which can serve to guide the design of photochemical and/or photovoltaic systems for a given environment. DOE

**N82-26817#** Applied Solar Energy Corp., City of Industry, Calif.  
**IMPROVED SLICING METHOD FOR SILICON Final Report**  
S. I. SOCLOF and P. A. ILES Sep. 1981 43 p refs  
(Contract DE-AC02-77CH-00178; EG-77-C-01-4042)  
(DE82-003517; SERI/TR-9010-1-T1) Avail: NTIS HC A03/MF A01

Orientation dependent etching as an improved slicing method to provide thin silicon slices with increased yields and suitable for processing into high efficiency solar cells was investigated. Slicing of silicon by chemically etching narrow slots through silicon slabs was unsuccessful in that many slots did not etch completely through the slabs. The etch slicing method presented severe requirements on the materials used to mask against the etchants, on precise angular alignment for opening up lines in the masks, and on the crystallographic perfection of the silicon. The extremely small aspect ratio of the slots caused problems in the etching of the slots. A matrix processing sequence for processing strips formed by the etching process into solar cells is developed. DOE

**N82-26824#** Sandia Labs., Albuquerque, N. Mex.  
**LUMINESCENT SOLAR-CONCENTRATOR DEVELOPMENT Final Report, 31 Jan. - 30 Jun. 1979**

P. S. FRIEDMAN Sep. 1981 148 p refs  
(Contract DE-AC04-76DP-00789)  
(DE82-000815; SAND-79-7059) Avail: NTIS HC A07/MF A01

Luminescent solar concentrators (LSCs) are studied. Characterization of LSC performance is emphasized. The areas investigated include the study of dyes in various hosts, development of an improved theoretical model for calculating efficiencies, investigation of both dye degradation and device operating temperatures, measurement of plate to cell optical coupling, photovoltaic cell optimization, use of inorganic glasses for LSCs, and a preliminary economic analysis. A collector efficiency of 1.9% was measured which represents approximately a 30% increase over previous values for the efficiency of an LSC coupled to a silicon photovoltaic cell. DOE

**N82-26825#** Automation Industries, Inc., Silver Spring, Md.  
**LOYOLA UNIVERSITY, NEW ORLEANS, LOUISIANA SOLAR ENERGY SYSTEM PERFORMANCE EVALUATION, FEBRUARY 1981 - JUNE 1981**

K. M. WELCH 1981 86 p refs  
(Contract DE-AC01-79CS-30027)  
(DE82-003357; SOLAR/1055-81/14) Avail: NTIS HC A05/MF A01

The Loyola University site is a student dormitory in New Orleans, Louisiana whose active solar energy system is designed to supply 52% of the hot water demand. The system is equipped with 4590 square feet of flat-plate collectors, a 5000-gallon water tank, auxiliary water supplied at high temperature and pressure from a central heating plant with a gas-fired boiler, and a differential controller that selects from 5 operating modes. System performance data are given, including the solar fraction, solar savings ratio, conventional fuel savings, system performance factor, and system coefficient of performance. The solar fraction is well below the design goal; this is attributed to great fluctuations in demand. Insolation, temperature, operation and solar energy utilization data are also presented. The performance of the collector, storage, and domestic hot water subsystems, the system operating energy, energy savings, and weather conditions are also evaluated. Appended are a system description, performance evaluation techniques and equations, site history, sensor technology, and typical monthly data. DOE

## 02 SOLAR ENERGY

**N82-26826# Automation Industries, Inc., Silver Spring, Md.  
SUMMERWOOD ASSOCIATES, HOUSE M, OLD SAYBROOK,  
CONNECTICUT: SOLAR ENERGY SYSTEM PERFORMANCE  
EVALUATION, JUNE 1980 - MAY 1981**

M. RAYMOND 1981 105 p refs  
(Contract DE-AC01-79CS-30027)  
(DE82-002240; SOLAR/1102-81/14) Avail: NTIS HC A06/MF  
A01

The active solar energy system is designed to supply 78% of the space heating and 100% of the hot water loads. It is equipped with 378 square feet of flat plate collectors, a 600-gallon concrete storage tank, and for auxiliary heating, a heat pump and electrical resistance heater. The system and subsystem performance are measured, including the solar fraction, solar savings ratio, conventional fuel savings, system performance factor, and solar system coefficient of performance. Also given are the system operating energy, energy savings, and weather conditions. DOE

**N82-26827# Automation Industries, Inc., Silver Spring, Md.  
SOLAR ENERGY SYSTEM PERFORMANCE EVALUATION:  
GENERAL ELECTRIC, NORMAL OPERATIONAL TEST SITE,  
NORMAL, ILLINOIS, SEPTEMBER 1980 - MARCH 1981**

S. J. FROCK 1981 86 p refs  
(Contract DE-AC01-79CS-30027)  
(DE82-001805; SOLAR/2098-81/14) Avail: NTIS HC A05/MF  
A01

This 2000 ft(2) single-family residence uses 356 ft(2) of evacuated tube collectors and a 380-gallon steel tank in the basement for solar space and water heating. An oil furnace provides auxiliary heating. The system provided 17% of the space heating and 42% of the water heating for the period. The problems incurred are mentioned. DOE

**N82-26829# Automation Industries, Inc., Silver Spring, Md.  
SOLAR-ENERGY-SYSTEM PERFORMANCE EVALUATION,  
RYMARK I AND RYMARK II, FREDERICK, MARYLAND,  
JANUARY 1981 - APRIL 1981**

J. W. SPEARS 1981 90 p refs  
(Contract DE-AC01-79CS-30027)  
(DE82-001591; SOLAR/1106-81/14) Avail: NTIS HC A05/MF  
A01

The Rymark I and Rymark II sites are single family residences in Maryland with a passive solar heating system in Rymark II. The Rymark I-system is equipped with 92 square feet of south-facing double-glazed windows and is designed to supply 16% of the heating load. The Rymark II system is equipped with 150 square feet of south-facing triple-pane windows and is designed to supply 28% of the heating load. Both houses are equipped with a 24,000 Btu heat pump. For each house, the equipment solar fraction and conventional fuel savings are given. Overall system performance data are presented as well as data on collector, storage, and space heating performance, energy savings, and weather conditions. DOE

**N82-26830# Automation Industries, Inc., Silver Spring, Md.  
SOLAR-ENERGY-SYSTEM PERFORMANCE EVALUATION,  
GENERAL ELECTRIC DALLAS OPERATIONAL TEST SITE,  
DALLAS, TEXAS, OCTOBER 1980 - MARCH 1981**

P. E. WETZEL 1981 86 p refs  
(Contract DE-AC01-79CS-30026)  
(DE82-001350; SOLAR/2094-81/14) Avail: NTIS HC A05/MF  
A01

The General Electric-Dallas site is a single family residence in Texas. The active solar energy system is a retrofit designed to supply 60% of the heating load, 75% of the hot water load, and 50% of the cooling load. The system is equipped with 365 square feet of evacuated tube collectors, 400 gallons of solar hot water storage, a three-ton heat pump for auxiliary heating and cooling, and a gas-fired, 40-gallon, domestic hot water heater. The solar fraction, solar savings ratio, conventional fuel savings, system performance factor, and solar system coefficient of performance are given, as well as performance data for the collector, storage, domestic hot water, space heating and space cooling subsystems,

solar operating energy, energy savings, and weather conditions. Predicted performance data are given for comparison with the measured values. DOE

**N82-26831# Automation Industries, Inc., Silver Spring, Md.  
SOLAR-ENERGY-SYSTEM PERFORMANCE EVALUATION,  
GENERAL ELECTRIC SPOKANE OPERATIONAL TEST SITE,  
SPOKANE, WASHINGTON, OCTOBER 1980 - MARCH 1981**

K. M. WELCH 1981 79 p refs  
(Contract DE-AC01-79CS-30027)  
(DE82-001610; SOLAR/2095-81/14) Avail: NTIS HC A05/MF  
A01

The General Electric-Spokane site is a YWCA building in Washington. The active solar energy system is designed to supply 45% of the heating load, 20% of the hot water load, and 60% of the pool heating load. It is equipped with 5,222 square feet of evacuated tube collectors, 6,700 gallons of water for heat storage, and an auxiliary natural gas-fired boiler. The solar fraction, solar savings ratio, conventional fuel savings, system performance factor, and solar savings ratio, conventional fuel savings, system performance factor, and solar system coefficient of performance is given, as well as performance data for the collector, storage, domestic hot water, space heating and pool heating subsystems, operating energy, energy savings, and weather conditions. DOE

**N82-26833# Midwest Research Inst., Golden, Colo. Solar Energy  
Research Inst.**

**CONCEPTUAL DESIGN OF THE TRUSCOTT BRINE LAKE  
SOLAR-POND SYSTEM, VOLUME 1: UTILITY-INDEPENDENT  
SCENARIO**

Jun. 1981 116 p refs Prepared for Army Corps of Engineers,  
Tulsa District  
(Contract DE-AC02-77CH-00178; EG-77-C-01-4042)  
(DE82-003024; SERI/TR-731-1202) Avail: NTIS HC A02/MF  
A01

A conceptual design was performed for a series of solar pond systems to provide pumping power for chloride control in the Red River Basin. In the chloride control project, briny waters are diverted so as not to pollute portable water. The diverted brine is stored in a dammed natural basin where, with the aid of natural evaporation, the brine is concentrated to the salinities required for the solar ponds. The brine is transferred to the ponds and injected at the proper levels to establish the gradients and storage layers. The solar ponds are to be located within the Truscott, Texas brine impoundment lake. Heat will be extracted from the ponds and used to drive organic Rankine-cycle turbine generators. The electricity produced will serve the pumping needs of the chloride control project, pump brine from the natural source to the evaporation ponds, pump concentrated brine from the evaporation ponds to the solar ponds, maintain the solar ponds, and supply all system parasitic loads. It was found that five solar ponds with eight organic Rankine-cycle turbine-generators would serve both the average and peaking power requirements of the pumping stations in the Truscott area as they come on-line. DOE

**N82-26834# Midwest Research Inst., Golden, Colo. Solar Energy  
Research Inst.**

**OPTICAL ANALYSIS AND OPTIMIZATION OF  
PARABOLIC-TROUGH COLLECTORS: A USER'S GUIDE**

P. BENDT, A. RABL, and H. W. GAUL Jul. 1981 32 p refs  
(Contract DE-AC02-77CH-00178; EG-77-C-01-4042)  
(DE82-003146; SERI/TR-631-602) Avail: NTIS HC A03/MF  
A01

An optical analysis of parabolic trough solar collectors is summarized using universal graphs and curve fits. These graphs enable the designer of parabolic trough collectors to calculate the performance and to optimize the design with a simple hand calculator. The sensitivity of the optimization to changes in collector parameters and operating conditions is evaluated. DOE

**N82-26836# Automation Industries, Inc., Silver Spring, Md.  
OAKMEAD INDUSTRIES, SANTA CLARA, CALIFORNIA  
SOLAR-ENERGY-SYSTEM PERFORMANCE EVALUATION  
OCTOBER 1980 - MAY 1981**

P. A. PAKKALA 1981 113 p refs  
(Contract DE-AC01-79CS-30027)  
(DE82-002508; SOLAR/2076-81/14) Avail: NTIS HC A06/MF A01

The Oakmead Industries solar energy system is a commercial office/manufacturing building in California equipped with 2622 square feet of liquid flat-plate collectors, 1675 square feet of Trombe wall glazing, a 6500-gallon steel storage tank, two gas-fired auxiliary space heating units and an auxiliary electric resistance water heater. The solar fraction, solar savings ratio, conventional fuel savings, system performance factor, and solar system coefficient of performance are calculated. The performance of the collector, storage, domestic hot water and space heating subsystems is examined, and the operating energy and energy savings are tabulated. Weather conditions are tabulated for the site. DOE

**N82-26837# Vitro Labs., Silver Spring, Md.  
RHRU CLEMSON, CLEMSON, SOUTH CAROLINA:  
SOLAR-ENERGY-SYSTEM PERFORMANCE EVALUATION,  
NOVEMBER 1980 - MAY 1981**

P. W. KENDALL 1981 105 p refs  
(Contract DE-AC01-79CS-30027)  
(DE82-002692; SOLAR-2086-81/14) Avail: NTIS HC A06/MF A01

The hybrid solar energy system is composed of a flat plate collector and greenhouse, and is designed to service the space heating and domestic hot water load while providing an environment for home food production. The equipment features a 388 square foot collector and 1161 cubic feet of crushed rock located under the building. The auxiliary equipment consists of electric resistance heaters for space heating and electric immersion heaters for domestic hot water. Detailed data on the energy savings realized from operation of the system from November 1980 to May 1981 are presented. Flow sheets show the flow of solar energy through the RHRU Clemson. Weather data for the Clemson area are given. DOE

**N82-26838# Sandia Labs., Albuquerque, N. Mex.  
CUSTOM ENGINEERING PARABOLIC GLASS REFLECTOR FOR  
THE SANDIA PROTOTYPE SOLAR COLLECTOR**

J. OTTS and D. SALLIS (Custom Engineering, Inc.) Aug. 1981 56 p  
(Contract DE-AC04-76DP-00789)  
(DE82-000800; SAND-81-1619) Avail: NTIS HC A04/MF A01

The design and construction of a parabolic glass reflector is described. A brief summary of its performance as part of the Sandia prototype trough solar collector system is given. DOE

**N82-26839# Sandia Labs., Albuquerque, N. Mex.  
DEVELOPMENT AND TESTING OF A  
HIGH-EFFICIENCY/HIGH-CONCENTRATION, PHOTOVOLTAIC  
MODULE EMPLOYING ALGAS/GAAS SOLAR CELLS**

R. J. OWEN, N. KAMINAR, P. G. BORDEN, P. E. GREGORY, and O. E. MOORE Oct. 1981 204 p refs Prepared in cooperation with Varian Associates, Inc., Palo Alto, Calif.  
(Contract DE-AC04-76DP-00789)  
(DE82-002683; SAND-81-7018) Avail: NTIS HC A10/MF A01

An advanced photovoltaic module employing high-concentration (400 suns) Fresnel lenses, high efficiency AlGaAs/GaAs solar cells, and jet-impingement cell cooling was designed. The prototype module produced approximately 100 W of dc power using 12 organometallic-vapor phase epitaxial (OM-VPE) cells (21 to 23% efficiency at 400 suns, 500 C) and 12 acrylic lenses and as designed for thermal energy recovery. The maximum module efficiency measured in Palo Alto, CA, was 17.1% compared to the 14% design goal. This performance was at 500 C coolant inlet temperature and reflected deduction of coolant pumping power. The module efficiency is 17.5% when corrected to NOCT conditions

(200 C coolant inlet temperature). Approximately 40 to 50% of the direct normal incident energy was determined to be available for recovery from the module coolant. The design and performance of a 3.2 kW/sub p/ photovoltaic array employing a further improved version of the module is also presented. DOE

**N82-26840# Grumman Aerospace Corp., Bethpage, N.Y.  
Research Dept.**

**ELECTROCHEMICAL PHOTOVOLTAIC CELLS 2-6 COMPOUND  
THIN FILM ELECTRODES Annual Report, Jun. 1980 - Jun. 1981**

M. A. RUSSAK, J. REICHMAN, J. DECARLO, and C. CRETER Jul. 1981 47 p refs Prepared for Midwest Research Inst., Golden, Colo.

(Contract DE-AC02-77CH-00178)  
(DE82-000394; GAC-RM-728; SERI/PR-8002-8-T) Avail: NTIS HC A03/MF A01

The program focused on developing stable, thin film II-VI compound electrodes with sunlight efficiencies of 10%, for use with aqueous polysulfide electrolyte in frontwall and backwall illuminated electrochemical photovoltaic cells. The main effort was directed towards establishing the relationships among processing of the thin films, resultant electronic properties, and I-V performance in order to produce electrodes with maximum power conversion efficiency. The efficiency of n-CdSe electrodes deposited on titanium substrates was improved from between 3 to 5% to 5.5% to 6.5% by refinement of the thin film processing parameters as well as electrode surface treatment with ZnCl<sub>2</sub> solution. The efficiency of n-CdSe electrodes deposited on tin oxide coated glass improved was from between 3 to 4% to the range of 6 to 6.5% due to modifications of the electrode geometry dictated by a photon loss minimization, and to electrode etching treatment. T.M.

**N82-26842# Midwest Research Inst., Kansas City, Mo. Solar  
Energy Research Inst.**

**STATE SOLAR INITIATIVES. VOLUME 1: A REVIEW**

R. KOONTZ, J. NEUENDORFFER, B. GREEN, N. GORDON, G. MYRING, E. PERWIN, B. POSTER, D. SMALL, and L. MYRING Sep. 1981 73 p refs 2 Vol.

(Contract DE-AC02-77CH-00178; EG-77-C-01-4042)  
(DE82-002425; SERI/TR-722-882-VOL-1) Avail: NTIS HC A04/MF A01

The impacts of solar energy programs undertaken in California, Florida, New Mexico, Minnesota, and New York are reviewed. Initiatives were explored: information outreach activities; consumer protection programs including standards, testing, certification, warranties, licensing, and consumer complaint offices; and tax credits and rebates. The experience in these five states is analyzed and conclusions and recommendations that will assist state governments in improving or launching their own programs are presented. DOE

**N82-26843# Midwest Research Inst., Kansas City, Mo. Solar  
Energy Research Inst.**

**STATE SOLAR INITIATIVES. VOLUME 2: A REVIEW**

R. KOONTZ, J. NEUENDORFFER, B. GREEN, G. MYRING, L. MYRING, E. PERWIN, N. GORDON, D. SMALL, and B. POSTER Sep. 1981 144 p refs 2 Vol.

(Contract DE-AC02-77CH-00178)  
(DE82-002838; SERI/TR-722-882-VOL-2) Avail: NTIS HC A07/MF A01

Background material supporting the solar energy recommendations and conclusions is provided. Research methodology, results of a computer program on state and federal tax credits, state energy goals, program lists, energy and demographic factors are contained. DOE

## 02 SOLAR ENERGY

**N82-26850#** Trinity Univ., San Antonio, Tex.  
**RESULTS OF ROOF POND HEATING EXPERIMENTS USING THE PASSIVE TEST FACILITY FOR WARM, HUMID CLIMATES**  
F. M. LOXSOM, P. OLIVARES, B. KELLY, E. CLARK, E. DODERER, and P. HAYES Sep. 1981 348 p refs  
(Contract DE-AC03-79CS-30201)  
(DE82-003226; DOE/CS-30201/T4) Avail: NTIS HC A15/MF A01

Passive cooling and heating methods in warm, humid climates were tested. During the winter of 1980-1981, heating experiments were carried out for roof pond systems. These experiments included: roof pond heating with glazed and unglazed water bags, heating roof ponds from below by using reflective blinds in south facing windows, and direct gain heating with the roof pond used as storage. The data for these experiments are in the form of 5 minute data for 160 sensors. Most of the sensors are thermocouples or heat flux meters. The data are stored on computer type in the form of 28 different data files for 28 different experiment periods. DOE

**N82-26856#** Boeing Computer Services, Inc., Seattle, Wash.  
**INTERMEDIATE PHOTOVOLTAIC SYSTEM APPLICATION EXPERIMENT OPERATIONAL PERFORMANCE REPORT. VOLUME 3: FOR NEWMAN POWER STATION, EL PASO, TEXAS Monthly Report, Feb. 1981**

Albuquerque, N. Mex. Sandia National Labs. Sep. 1981 48 p refs  
(Contract DE-AC04-76DP-00789)  
(DE82-000797; SAND-81-7086/3) Avail: NTIS HC A03/MF A01

Performance data are listed and graphed for an intermediate photovoltaic system for a power station in Texas. The array energy production incident solar energy, and array efficiency are given for each month, and the daily energy production and efficiency, and energy as a function of power and of voltage are graphed. Insolation, heating and cooling loads, temperature and wind data, and the number of freeze-thaw cycles are given for each month. DOE

**N82-26857#** Booz-Allen and Hamilton, Inc., Bethesda, Md.  
**SOLAR CENTRAL RECEIVERS: THE TECHNOLOGY, INDUSTRY, MARKETS, AND ECONOMICS**

1 Sep. 1981 155 p  
(Contract DE-AC03-81SF-11436)  
(DE82-005267; DOE/SF-11436/2) Avail: NTIS HC A08/MF A01

Major solar central receiver (SCR) technology development occurring in the public and private sectors is assessed. The economic characteristics of SCR systems are discussed and their ability to compete with conventional system costs is evaluated. The effects of various federal assistance options on the market prospects for SCR are quantified. The forms of possible federal assistance, impacts of such assistance on SCR costs, and the preference of potential SCR suppliers and purchasers towards these assistance options are identified. An overview is presented of private sector developers from which a viable supply industry can evolve and their capabilities to commercialize SCR techniques. DOE

**N82-26859#** Lincoln Lab., Mass. Inst. of Tech., Lexington.  
**SHARED INVERTER RESIDENTIAL PHOTOVOLTAIC SYSTEM CONCEPT**

E. C. KERN and F. J. SOLMAN Nov. 1981 9 p  
(Contract DE-AC02-76ET-20279)  
(DE82-006281; DOE/ET-20279/169) Avail: NTIS HC A02/MF A01

A residential photovoltaic system concept involving a number of separate roof mounted arrays all connected to a single utility interactive inverter is proposed and analyzed to compare systems employing one inverter for each array. The significance is that such shared inverter systems offer a costs savings of approximately 10%. It is observed that other substantial benefits might derive from a reduction in the number of tie in points between distributed generators and the electric utility grid. DOE

**N82-26861#** Pennsylvania Univ., Philadelphia. School of Public and Urban Policy.

**SOLAR ENERGY HOT WATER HEATING AND ELECTRIC UTILITIES. A MODEL VALIDATION Final Report**

Oct. 1981 41 p  
(Contract DE-AC02-80CS-30438)  
(DE82-005485; DOE/CS-30438/T1) Avail: NTIS HC A03/MF A01

TRNSYS is a residential solar simulation program designed to provide detailed simulations of individual solar systems composed of almost any presently used residential solar technology. The model is described and a validation of the model is presented using a group of domestic solar hot water systems in the metropolitan Philadelphia area. The collection and reduction of the data used is discussed, and the TRNSYS modeling of the systems is presented. The model results are given and a sensitivity analysis of the models was performed to determine the effect of input changes on the electric auxiliary backup consumption. DOE

**N82-26863#** Gibbs and Hill, Inc., New York.

**SOLAR-CENTRAL-RECEIVER SYSTEM INTEGRATED WITH A COGENERATION FACILITY FOR COPPER SMELTING, VOLUME 1 Final Report**

Aug. 1981 145 p  
(Contract DE-AC03-81SF-11533)  
(DE82-001580; DOE/SF-11533/T1-VOL-1) Avail: NTIS HC A07/MF A01

A cavity central receiver hybrid solar cogeneration retrofit for a smelting facility producing copper and sulfuric acid is described. Existing facilities and the southwest New Mexico site and the process for selection of the system configuration and subsystem criteria are described. The process involves: performance analyses, cost estimates, economic tradeoffs, and vendor quotations and consultation. An air based central receiver was selected, and sensible heat storage in rock is considered. A discounted cash flow analysis based upon the results of the conceptual design performance and cost estimates is performed. DOE

**N82-26865#** AAI Corp., Baltimore, Md.

**SOLAR PRODUCTION OF INDUSTRIAL-PROCESS HOT WATER. PHASE 3: OPERATION AND EVALUATION OF THE YORK BUILDING PRODUCTS CO., INC. SOLAR FACILITY Final Report, Sep. 1978 - Sep. 1981**

J. M. BOLLINGER, N. KAPLAN, and H. A. WILKENING, JR. Oct. 1981 95 p refs  
(Contract DE-AC03-76CS-31217)  
(DE82-003526; DOE/CS-31217/T8) Avail: NTIS HC A05/MF A01

A solar heating system to provide hot water for curing concrete blocks is discussed. The objective is to operate, collect data, and evaluate the solar system for a 3 year period. The solar facility utilizes 35 collectors. The system is designed to deliver a water/ethylene glycol solution at 2000 F to a heat exchanger, which, in turn, supplies water at 1800 F to a rotorclave (underground tank) for the concrete block curing process. A fossil fuel boiler system also supplies the rotorclave with processed hot water to supplement the solar system. The program demonstrates the technical feasibility of generating industrial process hot water with solar energy. DOE

**N82-27026#** Sandia Labs., Albuquerque, N. Mex. Systems Development Div.  
**USER'S MANUAL FOR DELSOL2: A COMPUTER CODE FOR CALCULATING THE OPTICAL PERFORMANCE AND OPTIMAL SYSTEM DESIGN FOR SOLAR-THERMAL CENTRAL-RECEIVER PLANTS**

T. A. DELLIN, M. J. FISH, and C. L. YANG Aug. 1981 76 p refs Prepared in cooperation with Sandia National Labs., Livermore

(Contract DE-AC04-76DP-00789)

(DE82-003875; SAND-81-8237) Avail: NTIS HC A05/MF A01

DELSOL2 is a revised and substantially extended version of the DELSOL computer program for calculating collector field performance and layout, and optimal system design for solar thermal central receiver plants. The code consists of a detailed model of the optical performance, a simpler model of the non-optical performance, an algorithm for field layout, and a searching algorithm to find the best system design. The latter two features are coupled to a cost model of central receiver components and an economic model for calculating energy costs. The code can handle flat, focused and/or canted heliostats, and external cylindrical, multi-aperture cavity, and flat plate receivers. The program optimizes the tower height, receiver size, field layout, heliostat spacings, and tower position at user specified power levels subject to flux limits on the receiver and land constraints for field layout. The advantages of speed and accuracy characteristic of Version I are maintained in DELSOL2. DOE

**N82-27378\*#** National Aeronautics and Space Administration. Marshall Space Flight Center, Huntsville, Ala.

**POWER SYSTEMS INTEGRATION**

L. W. BRANTLEY In NASA. Lewis Research Center Large Space Systems/Propulsion Interactions p 239-255 Jun. 1982  
 Avail: NTIS HC A12/MF A01 CSCL 22B

Power systems integration in large flexible space structures is discussed with emphasis upon body control. A solar array is discussed as a typical example of spacecraft configuration problems. Information on how electric batteries dominate life-cycle costs is presented in chart form. Information is given on liquid metal droplet generators and collectors, hot spot analysis, power dissipation in solar arrays, solar array protection optimization, and electromagnetic compatibility for a power system platform.

R.J.F.

**N82-27545#** Ruetgerswerke A.G., Frankfurt am Main (West Germany).

**SOLAR EQUIPMENT SYSTEM PACKAGES FOR OLD AND NEW BUILDINGS TO PROVIDE DOMESTIC WATER AND PARTIAL HEATING Final Report**

G. BERG and F. J. MUELLER Bonn Bundesministerium fuer Forschung und Technologie Mar. 1982 87 p refs In GERMAN; ENGLISH summary Sponsored by Bundesministerium fuer Forschung und Technologie (BMFT-FB-T-82-029; ISSN-0340-7608) Avail: NTIS HC A05/MF A01; Fachinformationszentrum, Karlsruhe, West Germany DM 18,30

Technically optimized and economically marketable system packages were investigated. Commercially available flat roof collectors failed long term (2 yr) tests. Architecturally, it is difficult to integrate the collectors into roof or wall surfaces due to their box design. Satisfactory integration is only achieved by including collectors in new building plans. Alternatively, a highly efficient plastic collector with long service life was developed. Although initial expenditure with conventional building construction is high, an improved cost-benefit relation is obtained, incorporating the flexible mat-shaped plastic absorber with fully wetted surface which is operated at pressure below atmospheric. Pilot plant results with a bivalent heat pump system prove collector capability. Design data for the absorber circuit and heat pump system are given.

Author (ESA)

**N82-27835\*#** IIT Research Inst., Chicago, Ill. Technology Transfer and Market Research Section.

**DOE/NASA SIMS PROTOTYPE SOLAR SYSTEM, NO. 4. PART 1: MARKET ANALYSIS. PART 2: MODULAR MANUFACTURING COST ESTIMATE**

Dec. 1979 105 p refs Original document contains color photographs

(Contract NASW-2837; NAS8-32229; NAS 1.26:169216; NASA-CR-169216)

Avail: NTIS HC A06/MF A01 CSCL 10B

The findings of the IIT Research Institute (IITRI) market study of the SIMS Prototype System 4, a hot water (DHW) system are documented. The feasibility of prepackaging currently available solar heating components into modular subsystems for site assembly is addressed. A documented design and installation procedure and a performance test report were prepared. The potential markets and applications for this particular system in the nonfederal market are profiled by assessing the needs and requirements of potential users and specifiers, by characterizing the nature of the market and the competitive environment, by identifying the barriers to commercial acceptance, and by estimating the size of the potential market.

Author

**N82-27836\*#** General Electric Co., Philadelphia, Pa. Energy Systems and Technology Div.

**INTEGRATED RESIDENTIAL PHOTOVOLTAIC ARRAY DEVELOPMENT Quarterly Report**

N. F. SHEPARD, JR. 17 Feb. 1981 65 p refs Sponsored in part by DOE Prepared for JPL

(Contract JPL-955894-1)

(NASA-CR-169112; JPL-9950-508; DOE/JPL-955894-1; NAS 1.26:169112; QR-1) Avail: NTIS HC A04/MF A01 CSCL 10A

An optimum integrated residential photovoltaic array/module is addressed. Nineteen existing or proposed systems intended for residential applications are described. Each of these systems is rated against a comprehensive set of evaluation criteria in an effort to formulate three module design concepts for further study and analysis. This evaluation led to a number of observations which are enumerated and should be considered in future module and array designs. Three module concepts are presented as baseline design approaches to be further analyzed and optimized. These options include: (1) a rectangular, direct mounted, shingle type module; (2) an integrally mounted module with nonconductive exposed elements; and (3) an aluminum framed, stand off module. Preliminary design drawings are presented for each of these module configurations.

Author

**N82-27840#** Coast Guard Research and Development Center, Groton, Conn.

**ACCELERATED STRESS TESTING OF SOLAR PHOTOVOLTAIC MODULES Interim Report**

S. E. TRENCHARD Sep. 1981 29 p refs

(AD-A107378; CGR/DC-25/81; USCG-D-59-81) Avail: NTIS HC A03/MF A01 CSCL 10B

The history of accelerated stress testing of solar photovoltaic modules is traced. The military standard tests to which the prototype modules were exposed and the results of that exposure are described. The evolution of the simultaneous multiple stress test to the present marine environment screening test is outlined. The results of exposure to the marine environment screening test of 136 test modules are reported.

Author

**N82-27847#** Insights West, Inc., Los Angeles, Calif.

**FUEL FROM THE SUN: SOLAR COMMERCIAL AND INDUSTRIAL APPLICATIONS FOR THE 1980'S**

Sep. 1981 51 p refs

(Contract DE-AC02-79CS-30159)

(DE82-003285; WSUN-74) Avail: NTIS HC A04/MF A01

The use of solar energy for industrial and commercial applications, particularly process heat, is presented. Flat plate, evacuated tube, and parabolic trough solar collectors are described briefly, and their temperature ranges and costs are given. Other solar technologies, including biomass conversion, wind power, solar

## 02 SOLAR ENERGY

ponds, photovoltaics, and passive design are also discussed. A checklist is given to help determine the feasibility of a solar heating system for a particular application. Economic aspects of using a solar energy system are discussed. Information is given on the installation and operation of a solar energy system, including the question of solar access. DOE

**N82-27852#** California Univ., Livermore. Lawrence Livermore Lab.

### **PHOTOVOLTAICS: CURRENT STATUS AND FUTURE PROJECTIONS**

D. W. DORN 19 Oct. 1981 14 p refs

(Contract W-7405-ENG-48)

(DE82-002684; UCID-19222) Avail: NTIS HC A02/MF A01

The generation of electricity by photovoltaic means was examined. Projections of near future developments are made, together with estimates of their impact on the cost and availability of photovoltaic systems for various markets. This concluded that photovoltaic systems should be able to deliver electricity at a cost of between 5 to 10 cents per kilowatt hour by 1986. DOE

**N82-27854#** Satzler (Ron), Princeville, Ill.

### **LOW COST, MULTIPURPOSE SOLAR ENERGY SYSTEM**

R. SATZLER 5 Aug. 1981 22 p

(Contract DE-FG02-79R5-10108)

(DE81-030955; DOE/R5-10108/2) Avail: NTIS HC A02/MF A01

A solar heating system is described using 3500 ft(2) of solar air heater collectors and 85 tons of rock storage. The system is designed for farm use and the following five purposes are discussed: grain drying, house heating, house cooling, domestic water heating, and workshop heating. DOE

**N82-27855#** Architects Taos, N. Mex.

### **PASSIVE SOLAR HEATING SYSTEM Final Technical Report**

W. MINGENBACH 28 Aug. 1981 139 p refs

(Contract DE-FC03-77CS-31513; EG-77-A-03-1513)

(DE82-003269; DOE/CS-31513/T1) Avail: NTIS HC A07/MF A01

The Taos State Office Building is a single-story office building in New Mexico which incorporates passive collection and storage of solar energy along with natural lighting for general illumination. The building is oriented to take advantage of early morning sunlight and is designed to supply 70% of the heating load by solar heat. The site is equipped with clerestory windows, totaling 2695 square feet, 296 square feet of south facing windows, and east and west window scoops totaling 218 square feet. The collected solar energy is stored in 14,080 gallons of water contained in drums located in the clerestory area, as well as in the masonry construction mass. Auxiliary heat is provided via electric strips in the supply ducts. Movable, insulated shutters are provided to reduce the loss from the clerestory window area at night. The project is described with pictures and diagrams of the final installation provided. An updated performance data report is included, and functional problems, general comments, maintenance and refurbishment recommendations are discussed. DOE

**N82-27858#** National Academy of Sciences - National Research Council, Washington, D. C.

### **ELECTRIC POWER FROM ORBIT: A CRITIQUE OF A SATELLITE POWER SYSTEM**

R. KASPER 1981 350 p refs

(Contract NSF PRM-79-19687)

(PB82-133083; NSF/PRM-81004) Avail: NTIS HC A15/MF A01 CSCI 10B

As a basis for assessing feasibility and projecting costs, this study focuses on the elements of a reference system which includes conceptual designs of various space vehicles and construction bases. The system uses photovoltaic devices for energy conversion in space and microwave devices for energy transmission to Earth. In addition to the major conclusions of the study, a number of detailed findings and recommendations are presented. These cover important technological aspects of a

satellite power system--economic analyses; environmental concerns; sociopolitical aspects of development; and a comparison of a satellite power system with potentially competing technologies that have prospects for meeting very long-term needs for electricity. GRA

**N82-27908#** Midwest Research Inst., Golden, Colo. Solar Energy Research Inst.

### **TERRESTRIAL SOLAR SPECTRA, SOLAR SIMULATION AND SOLAR CELL EFFICIENCY MEASUREMENT**

R. MATSON, R. BIRD, and K. EMERY Sep. 1981 121 p refs

(Contract EG-77-C-01-4042; DE-AC02-77CH-00178)

(DE82-002082; SERI/TR-612-964) Avail: NTIS HC A06/MF A01

Fundamentals of light transmittance and, both measured and modeled atmospheric effects (i.e., air mass, molecular and aerosol scattering, and absorption) on terrestrial solar spectra are discussed. Geometric effects, such as global rather than direct beam measurements, and detector orientation are also reviewed. The SERI proposed ASTM global and direct beam terrestrial solar spectra are also presented. A detailed review/evaluation of the spectral characteristics of a number of solar simulators is given. Methods of calibrating the short circuit current of a solar cell with respect to a given irradiance spectrum are discussed. In conclusion, the need for a sophisticated solar simulator is proportional to the spectral mismatch between the spectral response of the reference cell used to set the solar simulator and that of the test cell. The ASTM terrestrial solar irradiance spectrum is recommended as a reference, spectrum and, the used either filtered xenon arc or dichroic filtered tungsten halogen lamps for solar simulation is also recommended. DOE

## 03

### **HYDROGEN**

Includes hydrogen production, storage, and distribution.

**A82-31986#**

### **VERY LARGE AIRCRAFT WITH ALTERNATE FUELS - LH2 MOST PROMISING**

J. C. MUEHLBAUER (Lockheed-Georgia Co., Marietta, GA)

American Institute of Aeronautics and Astronautics, International Very Large Vehicles Conference, 2nd, Washington, DC, May 17, 18, 1982, 10 p. refs

(AIAA PAPER 82-0813)

Optimum designs of cargo aircraft using alternate fuels and carrying large payloads roundtrip over transoceanic distances without refueling are developed and compared. Synthetic jet propulsion (JP) fuel, liquid hydrogen (LH2) fuel, and nuclear power are considered. In relation to the JP aircraft, the LH2 aircraft is found to have lower ramp weights (by 25%) and lower trip costs (15%). The ramp weights and trip costs of the nuclear aircraft are, respectively, approximately 5 and 20% higher than those for the JP aircraft. With JP aircraft trip costs the most sensitive to fuel price, it is believed that rising prices in the future will make LH2 and nuclear power increasingly attractive. C.R.

**A82-31987#**

### **THE POTENTIAL FOR LONG-RANGE HIGH-PAYLOAD AIRCRAFT WITH ALTERNATE FUELS**

W. M. HAWKINS (Lockheed Corp., Burbank, CA)

American Institute of Aeronautics and Astronautics, International Very Large Vehicles Conference, 2nd, Washington, DC, May 17, 18, 1982, 7 p. refs

(AIAA PAPER 82-0814)

It is assumed that these aircraft will not be produced until the year 2005 and that they will use liquid hydrogen, which can be produced using coal, natural gas, or any other source of energy and water. With regard to propulsion, the present size of modern

high-by-pass engines will be employed; between 6 and 12 such units will be used on each aircraft. Control systems in use today to relieve structural loads will figure in the design, as will controls to avoid flutter, which at present are under development. Also considered possible is the use of precision rendezvous. It is pointed out that the cooling capacity of the liquid hydrogen fuel may be able to maintain laminar flow over a substantial portion of the aircraft by surface cooling. C.R.

**A82-32159**  
**HYDROGEN ECONOMY ASSESSMENT FOR LONG-TERM ENERGY SYSTEMS IN JAPAN**

T. OHTSUKA (Tohoku University, Sendai, Japan), M. AKIYAMA, T. SAITO, Y. ISHIZAKI, A. SUZUKI (Tokyo, University, Tokyo, Japan), N. NEGISHI, J. MORIYA, K. HOASHI, and T. HOSHINO (Industrial Research Institute, Tokyo, Japan) International Journal of Hydrogen Energy, vol. 7, no. 6, 1982, p. 455-462.

An assessment is made of hydrogen technology development; in particular, economy as an energy carrier, applicability for end-uses and the potential of the market in the future. Specifically, rough static cost comparisons are made on several modes of electricity transmission and hydrogen transport, and on several ways of off-peak electricity saving; including energy storage in the form of hydrogen. Then, the quantity of oil that could be saved from some representative end-use sectors if hydrogen fuel were to be introduced is discussed. Finally, a potential market is assessed, by projecting overall future energy supply/demand dynamics in Japan. (Author)

**A82-32164**  
**COOPERATIVE INTERNATIONAL LIQUID HYDROGEN AUTOMOTIVE PROGRESS REPORT**

W. J. D. ESCHER (Escher-Foster Technology Associates, Inc., St. Johns, MI) International Journal of Hydrogen Energy, vol. 7, no. 6, 1982, p. 519-521.

The current status of cooperative projects undertaken in West Germany, the United States and Japan for the road testing of liquid-hydrogen-fuelled passenger automobiles is indicated. The German vehicle uses a 1.8-l displacement, four-stroke cycle, four-cylinder normally aspirated engine using hydrogen injection at the individual intake valve ports and electronically controlled water induction to suppress backfiring and NO(x) emissions. A semiautomatic liquid hydrogen refuelling system has been developed which prechecks, fills and automatically terminates filling of the onboard tank system. The U.S. project makes use of a 3.8-l displacement four-stroke, six-cylinder turbocharged engine which has accumulated over 3000 km of driving with no instances of unsafe operation. The Japanese car is based on a 1.1-l displacement, two-stroke, three cylinder direct injected engine supplied with liquid hydrogen at about 10 atm pressure and -30 to -50 C, and offers superior fuel economy, acceleration and top speed performance compared to the standard gasoline-fuelled version. A.L.W.

**A82-32375**  
**HIGH TEMPERATURE FUEL AND STEAM ELECTROLYSIS CELLS USING PROTON CONDUCTIVE SOLID ELECTROLYTES**  
 H. IWAHARA, H. UCHIDA, and N. MAEDA (Tottori University, Tottori, Japan) Journal of Power Sources, vol. 7, Mar. 1982, p. 293-301. refs

High-temperature-type proton conductive solids are favorable materials as electrolytes for fuel cells and steam electrolysis cells for the production of hydrogen gas. An attempt has been made to construct a high temperature fuel cell and a steam electrolysis cell using an SrCeO<sub>3</sub>-based solid electrolyte, which was found to be a protonic conductor in the presence of hydrogen or water vapor. Both cells could be operated stably at 800 - 1000 C. The major limitation of the cell system was the resistance of the solid electrolytes. (Author)

**A82-35077#**  
**WILL HYDROGEN-FUELED AIRCRAFT BE SAFE**

G. D. BREWER (Lockheed-California Co., Burbank, CA) AIAA, SAE, and ASME, Joint Propulsion Conference, 18th, Cleveland, OH, June 21-23, 1982, AIAA 6 p. refs (AIAA PAPER 82-1236)

Analysis has shown that liquid hydrogen will be significantly safer than liquid methane and synjet, the other alternative fuels for aircraft. With LH<sub>2</sub> there will be less risk of a major spill occurring in event of a crash in which passengers can survive the impact. If fuel is spilled, and assuming ignition does not occur, LH<sub>2</sub> will not spread as far before it vaporizes, becomes buoyant, and dissipates in the atmosphere. If the spilled fuel is ignited, as will occur more than 80 percent of the time with any of the fuels, the resulting hydrogen fire will be of such short duration and will be confined to such a small area that the passenger survival rate can be expected to be much higher. (Author)

**A82-37436**  
**CONTINUOUS MICROBIAL PRODUCTION OF HYDROGEN GAS**

J. D. BROSSEAU and J. E. ZAJIC (Saskatchewan Research Council, Saskatoon; Western Ontario, University, London, Canada) International Journal of Hydrogen Energy, vol. 7, no. 8, 1982, p. 623-628. refs

Techniques utilized to study microbial hydrogen gas production involved intermittent flow digesters, chemostats (continuous culture), immobilized cells and immobilized enzymes. Overall, the chemostat appears to have the greatest potential to maximize hydrogen gas productivity. Immobilized systems tended to result in lower hydrogen-producing activities which may have been due to diffusion limitation. Organic compounds, such as carbohydrates, stimulate the greatest amount of H<sub>2</sub>. (Author)

**A82-37437**  
**SOLAR HYDROGEN PRODUCTION USING TWO-STEP THERMOCHEMICAL CYCLES**

E. BILGEN (Montreal, Universite, Montreal, Canada) and C. BILGEN (Exergy Research Corp., Montreal, Canada) International Journal of Hydrogen Energy, vol. 7, no. 8, 1982, p. 637-644. National Research Council refs (Contract NRC 11SQ31025-7-1509-5; NRC 08SX31155-8-6602)

In this paper, a thermodynamic study is presented on solar hydrogen production using concentrated solar energy and two-step thermochemical cycles. After discussing the temperature availability from solar installations and temperature requirements, two-step water decomposition processes using metal/metal oxide cycles are studied in detail. Some hybrid metal/metal oxide, purely thermochemical and hybrid, metal oxide/metal sulfate cycles are also discussed. The solar high temperature heat source is briefly analyzed and interfacing problems are discussed. (Author)

**A82-37444**  
**CATALYTIC COMBUSTION OF HYDROGEN. III - ADVANTAGES AND DISADVANTAGES OF A CATALYTIC HEATER WITH HYDROGEN FUEL**

M. HARUTA and H. SANO (Osaka, Government Industrial Research Institute, Ikeda, Japan) International Journal of Hydrogen Energy, vol. 7, no. 9, 1982, p. 737-740. refs

An experimental study of a catalytic heater with hydrogen fuel was conducted for comparison with a hydrocarbon-fuelled catalytic heater, in initiating temperature of combustion, adjustable heat output, and distribution of surface temperature of a catalyst. Hydrogen combustion was initiated at around room temperature even on pelletized oxides. There was no practical limitation of heat output on the lower side for hydrogen heaters, while 1.0 kcal/sq cm per hour was the lower limit for Liquefied Petroleum Gas and natural gas heaters. Since hydrogen is extremely light in comparison with air and flows upwards across the catalyst body, the distribution of catalyst temperature tended to be considerably non-uniform. (Author)

## 03 HYDROGEN

**A82-37445**

### **A NOVEL BATCH-TYPE HYDROGEN TRANSMITTING SYSTEM USING METAL HYDRIDES**

N. NISHIMIYA, A. SUZUKI, and S. ONO (National Chemical Laboratory for Industry, Tsukuba, Ibaraki, Japan) *International Journal of Hydrogen Energy*, vol. 7, no. 9, 1982, p. 741-750. refs

In the case of transporting hydrogen by means of metal hydrides, a key problem is to reduce the weight of the portable container filled with metal hydrides. The paper describes a novel batch-type hydrogen transmitting system characterized by a portable light container filled with metal hydrides, which is not pressure-proof but only mechanically durable. Hydriding is performed by setting the portable light container in a fixed pressure-proof vessel and admitting hydrogen and nitrogen inside and outside the portable container, respectively, while adjusting the pressure difference between both gases to be zero. Using this system, 2.9 cu Nm of hydrogen can be stored in 14.3 kg of the total mass of the solid constituents including 3.5 kg of Mg-10% Ni alloy. The portable container contains twice as much hydrogen per unit weight and volume as a conventional compressed gas cylinder. Due to the advanced design of this portable container, the optimum hydrogen content could be around 5 wt % based upon the total mass of the container. (Author)

### **N82-24689\*# Department of Energy, Washington, D. C. OVERVIEW OF THE CHEMICAL/HYDROGEN ENERGY SYSTEMS (C/HES) PROGRAM**

F. GORNICK *In Courtesy Associates, Inc. Proc. of the DOE Thermal and Chem. Storage Ann. Contractor's Rev. Meeting* p 141-144 Mar. 1981 Sponsored in part by JPL, Brookhaven National Lab. and DOE

Avail: NTIS HC A16/MF A01 CSCL 10A

The production, storage and transmission, and utilization of hydrogen are included. Management structure and the programmatic emphasis are summarized. Author

### **N82-24690\*# Department of Energy, Washington, D. C. CHEMICAL/HYDROGEN ENERGY STORAGE SYSTEMS**

D. S. MILLER and A. MEZZINA *In Courtesy Associates, Inc. Proc. of the DOE Thermal and Chem. Storage Ann. Contractor's Rev. Meeting* p 145-149 Mar. 1981 Sponsored in part by JPL and Brookhaven National Lab.

Avail: NTIS HC A16/MF A01 CSCL 10A

Electrochemical and thermochemical systems are reviewed. Chemical heat pumps, end-use applications and systems studies, and storage systems and materials are also discussed. N.W.

### **N82-24695# MPD Technology Corp., Wyckoff, N.J. Ergenics Div.**

#### **HYDRIDE CHEMICAL COMPRESSOR, PHASE 1**

P. P. TURILLON, F. E. LYNCH (Hydrogen Consultants, Inc.), and R. A. NYE (Denver Research Inst.) *In Courtesy Associates, Inc. Proc. of the DOE Thermal and Chem. Storage Ann. Contractor's Rev. Meeting* p 167-169 Mar. 1981 refs

Avail: NTIS HC A16/MF A01

A proof-of-concept bench-size hydride compressor was successfully built and tested. In continuous operation this unit delivered 20.3 liters/min (43SCFH) at a pressure of 42.2 atmospheres (650 Psia). The efficiency however was lower than anticipated. The operation of this small unit revealed several important factors which influence the overall efficiency of such a hydride hydrogen compressor. The reduced efficiency of the bench scale unit was caused by mechanical design details (such as excessive amount of copper due to the electrical heating system) as well as problems with the hydriding alloy (reduced capacity at elevated temperatures and decrease in plateau pressure after 700 cycles of operation). Author

### **N82-24696# MPD Technology Corp., Wyckoff, N.J. Ergenics Div.**

#### **DEVELOPMENT STATUS OF A METAL HYDRIDE PROCESS FOR HYDROGEN RECOVERY**

E. L. HUSTON *In Courtesy Associates, Inc. Proc. of the DOE Thermal and Chem. Storage Ann. Contractor's Rev. Meeting* p 170-171 Mar. 1981 refs

Avail: NTIS HC A16/MF A01

A new project seeking to develop and demonstrate a commercial metal hydride process for hydrogen recovery was initiated. The status of hydride separation technology is reviewed and the project milestones are summarized. Author

### **N82-24697# General Electric Co., Wilmington, Mass.**

#### **DEVELOPMENT STATUS OF SOLID POLYMER ELECTROLYTE WATER ELECTROLYSIS FOR LARGE SCALE HYDROGEN GENERATION**

J. H. RUSSELL *In Courtesy Associates, Inc. Proc. of the DOE Thermal and Chem. Storage Ann. Contractor's Rev. Meeting* p 172-174 Mar. 1981 refs

Avail: NTIS HC A16/MF A01

Solid polymer water electrolysis technology for large scale hydrogen generation is reviewed. A hydrogen generator module, capable of producing 2000 SCFH, was operated successfully for over 700 hours in the 200 kW system. Test results and further information are presented. Technology development was continued in support of improving both capital cost and conversion efficiency. Progress made in the development of the 10 sq ft active area cell included completion of the initial design, the beginning of fabrication development, and installation of new facilities for cell manufacture. Author

### **N82-24699# Life Systems, Inc., Cleveland, Ohio.**

#### **STATIC FEED WATER ELECTROLYSIS FOR LARGE SCALE HYDROGEN GENERATION**

F. H. SCHUBERT *In Courtesy Associates, Inc. Proc. of the DOE Thermal and Chem. Storage Ann. Contractor's Rev. Meeting* p 178-181 Mar. 1981 refs

Avail: NTIS HC A16/MF A01

The static feed water electrolysis concept for aerospace application was evaluated for application in large scale hydrogen generation. The inherent potential for low cost and high performance of this alkaline electrolyte based technique was investigated. A four task program addresses the following areas: (1) definition of upper current density levels possible with the static feed concept; (2) investigation of operation with contaminated water (e.g., seawater); (3) scaleup of cell area; and (4) definition of future scale up at the cell stack and system level. The scope of each of the four program tasks is defined. E.A.K.

### **N82-24704# Brookhaven National Lab., Upton, N. Y.**

#### **AMMONIA AS A HYDROGEN ENERGY-STORAGE MEDIUM**

G. STRICKLAND *In Courtesy Associates, Inc. Proc. of the DOE Thermal and Chem. Storage Ann. Contractor's Rev. Meeting* p 201-203 Mar. 1981 refs

Avail: NTIS HC A16/MF A01

Liquid Hydrogen (LH<sub>2</sub>), Methanol (MeOH), and Ammonia (NH<sub>3</sub>) are compared as hydrogen energy-storage media on the basis of reforming the MeOH to produce H<sub>2</sub> and dissociating (cracking) the NH<sub>3</sub> to release H<sub>2</sub>. The important factors in this storage concept are discussed. It is shown that, in terms of energy input for media manufacture from natural gas, hydrogen energy content of the medium, and energy cost NH<sub>3</sub> has a wide advantage and comes the closest to matching gasoline. The tasks required in developing a safe and practical hydrogen energy-storage system based on the storage and cracking of NH<sub>3</sub> are listed. E.A.K.

## FUELS AND OTHER SOURCES OF ENERGY

Includes fossil fuels, nuclear fuels, geothermal and ocean thermal energy, tidal energy, and wind energy.

**N82-24705#** Billings Energy Corp., Independence, Mo.  
**MODIFICATION AND OPERATION OF THE HYDROGEN HOMESTEAD HYDRIDE VESSEL ENERGY STORAGE SYSTEM**  
 R. E. BILLINGS /In Courtesy Associates, Inc. Proc. of the DOE Thermal and Chem. Storage Ann. Contractor's Rev. Meeting p 204-210 Mar. 1981 refs  
 Avail: NTIS HC A16/MF A01

The safe storage of the hydrogen fuel for use in hydrogen energy was studied. The performance characteristics of bulk hydride storage is investigated. Experimental design and operating proceedings are described which include: hydrogen production, drying, purification and safety system drying, as well as the monitoring of flow, temperature, pressure data and girth measurement.  
 E.A.K.

**N82-24706#** Factory Mutual Research Corp., Norwood, Mass.  
**HYDROGEN MICROSPHERE HAZARD EVALUATION**  
 R. G. ZALOSH and S. N. BAJPAI /In Courtesy Associates, Inc. Proc. of the DOE Thermal and Chem. Storage Ann. Contractor's Rev. Meeting p 211-213 Mar. 1981 refs  
 Avail: NTIS HC A16/MF A01

Progress on a preliminary hazard evaluation of hollow glass microspheres for hydrogen transport and storage is reported. The flammability and explosibility of representative hydrogen filled microspheres was assessed. The tests include dust cloud explosion; flame propagation; impact sensitivity; spark ignition; and autoignition furnace. The microspheres can be ignited and propagate flame either in the quiescent bulk form or as a suspended cloud. A preliminary comparison with flammability data for gaseous hydrogen and iron titanium hydride powder indicate that the autoignition temperature of hydrogen filled microspheres is comparable to that of the other forms of hydrogen, but suspended clouds of microspheres produce lower explosion pressures than hydride dust or hydrogen gas. Safety codes and government regulations pertinent to hydrogen filled microspheres are also reviewed.  
 E.A.K.

**N82-24710\*#** Jet Propulsion Lab., California Inst. of Tech., Pasadena.

**PRODUCTION COST COMPARISONS OF HYDROGEN FROM FOSSIL AND NUCLEAR FUEL AND WATER DECOMPOSITION**  
 K. R. EKMAN /In Courtesy Associates, Inc. Proc. of the DOE Thermal and Chem. Storage Ann. Contractor's Rev. Meeting p 227-231 6 Mar. 1981 refs Sponsored in cooperation with DOE

Avail: NTIS HC A16/MF A01

The comparative costs entailed in producing hydrogen by major technologies that rely on petroleum, natural gas, coal, thermochemical cycles, and electrolysis are examined. Techniques were developed for comparing these processes by formulating the process data and economic assessments on a uniform and consistent basis. These data were normalized to permit a meaningful comparative analysis of product costs of these processes.  
 S.L.

**N82-24711\*#** Jet Propulsion Lab., California Inst. of Tech., Pasadena.

**RECENT WORK IN ADVANCED HYDROGEN PRODUCTION CONCEPTS**

D. D. LAWSON /In Courtesy Associates, Inc. Proc. of the DOE Thermal and Chem. Storage Ann. Contractor's Rev. Meeting p 232 Mar. 1981 refs  
 Avail: NTIS HC A16/MF A01

The hydrogen photoelectrolytic conversion activity investigated the practicability of semiconductor electrolytic devices that use solar energy to decompose water into hydrogen and oxygen in an apparent single step process. The photocatalytic decomposition of inorganic hydrogen compounds; i.e., hydrobromic and hydriodic acids using rhodium organic bridge complexes were also studied. The feasibility of direct high temperature thermal decompositions of water with diffusion processes for separation of the equilibrium mixture of hydrogen and oxygen into usable energy sources was examined.  
 S.L.

**A82-28660**

**NOX FORMATION IN FLAT, LAMINAR, OPPOSED JET METHANE DIFFUSION FLAMES**

W. A. HAHN and J. O. L. WENDT (Arizona, University, Tucson, AZ) In: Symposium /International/ on Combustion, 18th, Waterloo, Ontario, Canada, August 17-22, 1980, Proceedings. Pittsburgh, PA, Combustion Institute, 1981, p. 121-129; Comments, p. 129-131. U.S. Environmental Protection Agency refs  
 (Contract EPA-68-02-2631; EPA-R-803715)

Diffusion flames can play a useful role in the study of the kinetic mechanisms of pollutant formation. A laminar diffusion flame which has a number of useful attributes is the flat laminar opposed jet diffusion flame. Such a flame is established between two coaxial opposed jets, one being fuel only and the other being oxidizer only, impinging on one other. This flame is strained in its own plane, and it can be envisioned as a prototype model for laminar flamelets in turbulent diffusion flames. It is shown that the considered flame, having a given stretching rate, is one dimensional in temperature, concentration, and axial, but not radial, velocity profiles, provided the correct boundary conditions are employed for the velocities of the two incoming jets.  
 G.R.

**A82-28672**

**FLAME PROPAGATION IN HETEROGENEOUS MIXTURES OF FUEL DROPLETS, FUEL VAPOR AND AIR**

D. R. BALLAL (GM Research Laboratories, Warren, MI) and A. H. LEFEBVRE (Purdue University, West Lafayette, IN) In: Symposium /International/ on Combustion, 18th, Waterloo, Ontario, Canada, August 17-22, 1980, Proceedings. Pittsburgh, PA, Combustion Institute, 1981, p. 321-328; Comments, p. 328. refs

The reported experimental investigations make use of a technique for generating flat flames in tubes which has not been applied previously to heterogeneous mixtures. The obtained results are used as a basis for the formulation of a model. The model, which is based on considerations of evaporation rates and chemical reaction rates, describes the rate of flame propagation through quiescent multidroplet mists. When evaporation times are long relative to reaction times, flame speed is enhanced by increases in gas density, fuel volatility, vapor concentration, and reduction in mean drop size. However, when chemical reaction times are limiting to the rate of flame propagation, the flame speed reverts to the normal burning velocity for the mixture.  
 G.R.

**A82-28679**

**EXPERIMENTAL INVESTIGATION OF METHANOL OXIDATION IN FLAMES MECHANISMS AND RATE CONSTANTS OF ELEMENTARY STEPS**

J. VANDOOREN and P. J. VAN TIGGELEN (Louvain, Universite Catholique, Louvain, Belgium) In: Symposium /International/ on Combustion, 18th, Waterloo, Ontario, Canada, August 17-22, 1980, Proceedings. Pittsburgh, PA, Combustion Institute, 1981, p. 473-482; Comments, p. 482, 483. Fonds National de la Recherche Fondamentale Collective refs  
 (Contract FRFC-2,9009,76)

An experimental study of methanol combustion in laminar flames is described that provides detailed information on the principal paths of methanol consumption and on subsequent elementary reactions. Data for the rate constants involved in the oxidation of methanol are given and the combustion processes of methane and methanol are compared. The different species in the flame front were analyzed with a molecular beam sampling technique coupled with a mass spectrometer. About 70 percent of the fuel molecules are consumed by reaction with hydroxyl radical and 30 percent by reaction with the hydrogen atom. The main product is

## 04 FUELS AND OTHER SOURCES OF ENERGY

CH<sub>2</sub>OH or CH<sub>3</sub>O radical. These may in turn disappear either with molecular oxygen or with other radicals. During oxidation all methanol goes through a formaldehyde stage that either reacts with radicals or disappears in a bimolecular decomposition process. C.D.

**A82-28681**

### STABILITY LIMITS OF NATURAL GAS DIFFUSION FLAMES WITH SWIRL

R. RAWE (Munster, Fachhochschule, Munster, West Germany) and H. KREMER (Bochum, Ruhr-Universitat, Bochum; Gaswarme-Institut, Essen, West Germany) In: Symposium /International/ on Combustion, 18th, Waterloo, Ontario, Canada, August 17-22, 1980, Proceedings. Pittsburgh, PA, Combustion Institute, 1981, p. 667-675; Comments, p. 675-677. refs

Complete blow-off limits are investigated as a function of swirl and burner geometry, quantitative information for the calculation of flame stability limits is provided, and a model is developed for swirling flame stabilization. The dependence of blow-off velocity on the fuel to air ratio was determined for a number of burner geometries and swirl levels, and it was found that flame stability expressed in terms of the tangential velocity component increases continuously with increasing swirl strength. The study of geometrical parameters revealed that increasing the diameter of the central fuel pipe improves flame stability. The stability limits of swirling flames are correlated by means of a dimensionless Peclet number based on the maximum tangential velocity component. The stability of swirling diffusion flames depends on the location of the stoichiometric mixture within the flow field near the burner exit. C.D.

**A82-28690**

### THE TURBULENT REACTION FIELD IN A CONCENTRIC DIFFUSION FLAME

R. GUENTHER and V. WITTMER (Karlsruhe, Universitaet, Karlsruhe, West Germany) In: Symposium /International/ on Combustion, 18th, Waterloo, Ontario, Canada, August 17-22, 1980, Proceedings. Pittsburgh, PA, Combustion Institute, 1981, p. 961-967. refs

The flame of a concentric double jet, the central jet consisting of natural gas and the ring jet of air, was studied in free surroundings. Time mean values, fluctuations of axial and radial velocity, nozzle fluid concentration, ionization and temperature were measured. Data for the most important correlation terms of the momentum equation were obtained. The structure of the reaction zone was studied by deriving the necessary reaction area from the respective data for a laminar flame. There is reason to believe that about 1 sq cm/s is a suitable mean diffusion coefficient for turbulent methane flames. From the radial and axial distances of ionization fronts as well as from photographs it can be inferred that combustion occurs mainly in flat burning sheets, oriented parallel to the main flow and symmetrical to the axis. C.D.

**A82-28692**

### THE COMBUSTION OF A FUEL JET IN A STREAM OF LEAN GASEOUS FUEL-AIR MIXTURES

G. A. KARIM, I. WIERZBA, M. METWALLY, and K. MOHAN (Calgary, University, Calgary, Alberta, Canada) In: Symposium /International/ on Combustion, 18th, Waterloo, Ontario, Canada, August 17-22, 1980, Proceedings. Pittsburgh, PA, Combustion Institute, 1981, p. 977-990; Comments, p. 990, 991. Research supported by the National Research Council of Canada, Imperial Oil, Ltd., and University of Calgary. refs

The purpose is to establish the way in which the presence of a fuel vapor homogeneously dispersed in the surrounding air influences the burning characteristics of the jet flame and the corresponding flammability limits for both co-flowing and contra-flowing surrounding streams in the presence of a pilot jet diffusion flame. A wide range of jet diameters and discharge velocities is employed involving methane or hydrogen at ambient temperature and pressure. Both laminar and turbulent co-flowing streams are considered; the streams involve a range of gaseous fuel-air mixtures and include methane, hydrogen, propane and

ethylene. It is shown that the presence of very small concentrations of fuel in the surroundings of the jet flame tends to increase the flame thickness and height and to considerably enhance its stabilization. It is also found that the detected flame spread lean limit of the fuels is essentially independent of the type of jet fuel and the initial jet discharge velocity. C.R.

**A82-29327**

### DETECTION OF ENVIRONMENTAL DISTURBANCE USING COLOR AERIAL PHOTOGRAPHY AND THERMAL INFRARED IMAGERY

S. ARONOFF and G. A. ROSS (Calgary, University, Calgary, Alberta, Canada) Photogrammetric Engineering and Remote Sensing, vol. 48, Apr. 1982, p. 587-591. Research supported by the Alberta Oil Sands Environmental Research Program. refs

Characteristics of a program for satellite remote sensing for long-period environmental monitoring are examined, noting that establishing early mapping surveys of areas of concern aids in detection of stressful environmental conditions. The process is described with an example from IR and color photography of a 30,000 sq km area in the Athabasca Oil Sands, with the photography carried out from aircraft and satellite. The IR data was gathered between 8-14 microns and the photographs were taken at a 1:11,000 scale. Water-related disturbances detected included turbidity which indicated the possible presence of oil, and higher thermal emission near a tailings pond which also suggested an oil source. The presence of surface aquatic vegetation is an indicator of nutrient imbalance in a pond near a sewage pond. Finally, dead trees were observed near improperly installed culverts along new roads. M.S.K.

**A82-31244**

### THE MT. HOOD REGION - VOLCANIC HISTORY, STRUCTURE, AND GEOTHERMAL ENERGY POTENTIAL

D. L. WILLIAMS, H. D. ACKERMANN (U.S. Geological Survey, Denver, CO), D. A. HULL (Oregon, Dept. of Geology and Mineral Industries, Portland, OR), and M. H. BEESON (Portland State University, Portland, OR) Journal of Geophysical Research, vol. 87, Apr. 10, 1982, p. 2767-2781. Research supported by the U.S. Geological Survey, U.S. Department of Energy, and Oregon Department of Geology and Mineral Industries. refs

**A82-31886#**

### STATIONARY THERMAL IGNITION OF PARTICLE SUSPENSIONS

H. KHALIL, J. K. SHULTIS, and T. W. LESTER (Kansas State University of Agriculture and Applied Science, Manhattan, KS) American Institute of Aeronautics and Astronautics and American Society of Mechanical Engineers, Joint Thermophysics, Fluids, Plasma and Heat Transfer Conference, 3rd, St. Louis, MO, June 7-11, 1982, AIAA 12 p. Research supported by the Kansas State University of Agriculture and Applied Science and Alexander von Humboldt Stiftung. refs (AIAA PAPER 82-0881)

A calculational method is presented for the stationary thermal ignition of pulverized coal suspensions, based on radiative energy transport in a heat generating medium. A diffusion-limited, Arrhenius model for heat generation is used in the description of the heterogeneous ignition and combustion of particles with the gases in which they are dispersed. The discrete ordinates method, which is used to solve numerically the radiative transfer equation, is combined with an iterative procedure to obtain both the temperature and radiation intensity distributions throughout the reacting system. Numerical examples are presented to show the variation in the critical behavior of a system in plane geometry with wall temperature and reflectivity, optical thickness of the system, particle size, optical parameters, anisotropy of the scattering, and the parameters of the heat generation model. (Author)

A82-32333

**NET ENERGY ANALYSIS OF METHANOL AND ETHANOL PRODUCTION**

H. PEREZ-BLANCO (Oak Ridge National Laboratory, Oak Ridge, TN) and B. HANNON (Illinois, University, Urbana, IL) *Energy* (UK), vol. 7, Mar. 1982, p. 267-280. refs  
(Contract W-31-109-38-5154)

Methanol (MeOH) and ethanol (EtOH) are industrial alcohols that can be used as liquid fuels. They may be obtained from renewable or non-renewable feedstocks. The production processes and end uses are analyzed in order to assess the potential energy savings introduced by alcohol production from renewable instead of nonrenewable feedstock. Whereas MeOH production from wood brings about energy savings, EtOH production from corn may or may not save energy depending on the end use of the alcohol. If the alcohol is used as a motor fuel, no overall energy savings are found. The economics and total labor requirements of each process are also considered. (Author)

A82-32443\* Columbia Univ., New York.

**HIGH SPECTRAL RESOLUTION AIRBORNE SPECTROMETRY**

W. COLLINS, S. CHANG, J. T. KUO (Columbia University, New York, NY), M. DOUMA, S. MARSHALL (Massachusetts Manufacturing Corp., Cambridge, MA), and P. MURPHY (Sanders Associates, Inc., Nashua, NH) In: *Imaging spectroscopy; Proceedings of the Seminar, Los Angeles, CA, February 10, 11, 1981. Bellingham, WA, SPIE - The International Society for Optical Engineering, 1981, p. 22-28*  
(Contract JPL-955832; NSF ENG-78-24432)

An airborne spectroradiometer system developed at Columbia University has been providing new spectral data for use in remote sensing for natural resources. The system has been improved by addition of a solid state silicon detector array, and has been extended into the infrared by addition of a 64 element lead sulfide detector array. The infrared data in the 2000 to 2500 nm region especially holds large potential for mineral and oil exploration.

(Author)

A82-34487

**COAL TO ELECTRICITY - INTEGRATED GASIFICATION COMBINED CYCLE**

J. C. CORMAN (GE Research and Development Center, Schenectady, NY) *Applied Energy*, vol. 10, Apr. 1982, p. 243-259. refs  
(Contract EX-76-C-01-1806)

An advanced energy conversion system - the integrated gasification combined cycle (IGCC) - has been identified as an efficient and economical means of converting coal to electricity for utility application. Several demonstration projects on a near-commercial scale are approaching the construction stage. A coal conversion facility has been constructed to simulate the operational features of an IGCC. This process evaluation facility (PEF-scale) performs a dual function: (1) acquiring and processing data on the performance of the individual components - coal gasifier, gas clean up, and turbine simulator - that comprise the IGCC concept and (2) simulating the total system in an operational control mode that permits evaluation of system response to imposed load variations characteristic of utility operation. The results to date indicate that an efficient, economical IGCC can be designed so that the gasification/gas clean up plant and the power generation system operate compatibly to meet utility requirements in an environmentally acceptable manner. (Author)

A82-35293#

**PLAIN-JET AIRBLAST ATOMIZATION OF ALTERNATIVE LIQUID PETROLEUM FUELS UNDER HIGH AMBIENT AIR PRESSURE CONDITIONS**

A. K. JASUJA (Cranfield Institute of Technology, Cranfield, Beds., England) *American Society of Mechanical Engineers, International Gas Turbine Conference and Exhibit, 27th, London, England, Apr. 18-22, 1982, 7 p. Research supported by the Ministry of Defence (Procurement Executive). refs*  
(ASME PAPER 82-GT-32) MEMBERS, \$2.00; NONMEMBERS, \$4.00

The effects that air and fuel properties have upon the spray mean drop size characteristics of a plain-jet airblast atomizer of the type employed in the gas turbine engine are investigated. The tests used kerosene, gas oil and a high-viscosity blend of gas oil in residual fuel oil, and covered a wide range of ambient air pressures. Laser light-scattering technique was employed for drop size measurements. It is concluded that the atomizer's measured mean drop size characteristics are only slightly different from those of the pre-filming type, especially when operating on low-viscosity kerosene under higher ambient air pressure. The beneficial effect of increased levels of ambient air pressure on mean drop size is shown to be much reduced in the case of high-viscosity fuels, thus making the attainment of good atomization performance on such fuels difficult. An expression is derived for correlating the obtained mean drop size data. C.D.

A82-35307\*# United Technologies Research Center, East Hartford, Conn.

**DEPOSIT FORMATION IN HYDROCARBON FUELS**

R. ROBACK, E. J. SZETELA, and L. J. SPADACCINI (United Technologies Research Center, East Hartford, CT) *American Society of Mechanical Engineers, International Gas Turbine Conference and Exhibit, 27th, London, England, Apr. 18-22, 1982, 9 p. refs*  
(Contract NAS3-22277)

(ASME PAPER 82-GT-49) MEMBERS, \$2.00; NONMEMBERS, \$4.00

The hydrocarbon fuels RP-1, commercial-grade propane, JP-7 and chemically pure propane were subjected to tests in a high pressure fuel coking apparatus in order to evaluate their thermal decomposition limits and carbon deposition rates in heated copper tubes. A fuel thermal stability parametric evaluation was conducted at 136-340 atmospheres, bulk fuel velocities of 6-30 m/sec, and tube wall temperatures of 422-811 K, and the effect of inside wall material on deposit formation was evaluated in tests using nickel-plated tubes. Results show RP-1 deposit formation at wall temperatures between 600 and 800 K, with peak deposit formation near 700 K. Substitution of deoxygenated JP-7 for RP-1 showed no improvement, and the carbon deposition rates for propane fuels were found to be higher than those of either of the kerosene fuels. Nickel plating of the tube walls significantly reduced RP-1 carbon deposition rates. O.C.

A82-35330#

**CARBON FORMATION BY THE PYROLYSIS OF GAS TURBINE FUELS IN PREFLAME REGIONS OF GAS TURBINE COMBUSTORS**

C. D. HURLEY (National Gas Turbine Establishment, Farnborough, Hants., England) *American Society of Mechanical Engineers, International Gas Turbine Conference and Exhibit, 27th, London, England, Apr. 18-22, 1982, 7 p. refs*  
(ASME PAPER 82-GT-84) MEMBERS, \$2.00; NONMEMBERS, \$4.00

A series of experiments is carried out to investigate the formation of carbon from the pyrolysis of gas-turbine fuels, in both the gas and liquid phases, over the temperature range 573-1300 K. Two fuels are examined, a kerosene and a diesel, spanning the range of current and possible future aviation fuels. It is found that only gas-phase pyrolysis can account for the formation of carbon and that there is no difference in the carbon-forming tendencies of kerosene and diesel. The kinetics of the reaction is determined, making it possible to predict the amount of

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decomposition of the fuels at temperatures up to those typical of the preflame regions of combustors. C.R.

### A82-35362#

#### THE POTENTIAL IMPACT OF FUTURE FUELS ON SMALL GAS TURBINE ENGINES

J. A. SAINTSBURY (Pratt and Whitney Aircraft of Canada, Ltd., Longueuil, Quebec, Canada) and P. SAMPATH American Society of Mechanical Engineers, International Gas Turbine Conference and Exhibit, 27th, London, England, Apr. 18-22, 1982, 8 p. refs (ASME PAPER 82-GT-133) MEMBERS, \$2.00; NONMEMBERS, \$4.00

The present investigation is based on the assumption that in the not too distant future aviation gas turbine fuels as they are known today will not be available and that it will be necessary to accept either degraded fuels or fuels derived from sources presently considered unconventional. The investigation addresses gas turbine fuels in general and their effect on combustion systems, giving particular attention to small gas turbine engine combustion systems. It is found that the impact of future fuels on aircraft gas turbine engines will vary depending on engine size and type, because of differences in fundamental design criteria, and constraints of weight, cost, and size. As a first step towards fuel conservation pending availability of viable alternate energy sources, broadened specification fuels with modest relaxations in aromatics, and freeze point will likely be in use in the near term, but fuels from alternate sources will be longer term because of the need to develop an appropriate production industry. G.R.

### A82-36175#

#### AN ALTERNATE TEST PROCEDURE TO QUALIFY FUTURE FUELS FOR NAVY AIRCRAFT

C. A. MOSES, N. R. SEFER, and M. L. VALTIERRA (Southwest Research Institute, San Antonio, TX) AIAA, SAE, and ASME, Joint Propulsion Conference, 18th, Cleveland, OH, June 21-23, 1982, AIAA 9 p. refs (Contract N00140-80-C-2269) (AIAA PAPER 82-1233)

The U.S. Navy is experiencing pressures to modify the JP-5 fuel specification because of the growing shortage of high-quality crude oils from which kerosene can be simply distilled, and the increased costs of refining lesser quality crude oils to meet the current specification. A program has been initiated with the objective to study and develop a qualification procedure for future fuels. The purpose of the Alternative Test Procedure (ATP) would be to reduce the number of large-scale engine and flight tests required to develop confidence that a new fuel type will perform satisfactorily. Attention is given to future Navy aircraft fuels, the impact of future fuels on aircraft systems, aspects of hot section durability, materials compatibility, lubricity, cold day ignition, and thermal stability. It is concluded that an ATP to qualify future fuels is both necessary and feasible. G.R.

N82-22326\*# Westinghouse Electric Corp., Concordville, Pa. Combustion Turbine Systems Div.

#### LOW NO SUB X HEAVY FUEL COMBUSTOR CONCEPT PROGRAM. PHASE 1A: COMBUSTION TECHNOLOGY GENERATION COAL GAS FUELS Final Report

T. P. SHERLOCK Feb. 1982 57 p refs (Contract DEN3-146; DE-AI01-77ET-13111) (NASA-CR-165614; DOE/NASA/0146-2; NAS 1.26:165614) Avail: NTIS HC A04/MF A01 CSCL 20B

Combustion tests of two scaled burners using actual coal gas from a 25 ton/day fluidized bed coal gasifier are described. The two combustor configurations studied were a ceramic lined, staged rich/lean burner and an integral, all metal multiannual swirl burner (MASB). The tests were conducted over a range of temperature and pressures representative of current industrial combustion turbine inlet conditions. Tests on the rich lean burner were conducted at three levels of product gas heating values: 104, 197 and 254 btu/scf. Corresponding levels of NOx emissions were 5, 20 and 70 ppmv. Nitrogen was added to the fuel in the form of ammonia, and conversion efficiencies of fuel nitrogen to NOx were

on the order of 4 percent to 12 percent, which is somewhat lower than the 14 percent to 18 percent conversion efficiency when src-2 liquid fuel was used. The MASB was tested only on medium btu gas (220 to 270 btu/scf), and produced approximately 80 ppmv NOx at rated engine conditions. Both burners operated similarly on actual coal gas and erbs fuel, and all heating values tested can be successfully burned in current machines. S.L.

### N82-22334# Rockwell International Corp., Canoga Park, Calif. INVESTIGATION OF COAL-GASIFICATION CATALYSIS-REACTION MECHANISMS Quarterly Technical Progress Report, Jan. - Mar. 1981

L. R. MCCOY, J. P. AMPAYA, R. C. SAUNDERS, and L. A. HEREDY Apr. 1981 19 p (Contract DE-AC21-80MC-14592) (DE82-003305; DOE/MC-14592/T2) Avail: NTIS HC A02/MF A01

The installation of a thermogravimetric analysis balance in a pressure enclosure capable of operation at up to 3.4 MPa with a char sample temperature of 850 C and the calibration of the balance and associated components are described. The system was placed in satisfactory operation, and essential calibration procedures were carried out. Procedures for preparation of catalyzed and noncatalyzed char from Illinois No. 6 coal obtained from the Pennsylvania State University Coal Data Bank were finalized, and char is produced on a routine basis. To expedite checkout of the balance system, experimental gasification of char with carbon dioxide was carried out. Initial gasification tests with CO2 show good reproducibility. T.M.

### N82-22335# Georgia Univ., Athens. Dept. of Chemistry. CHROMATOGRAPHIC STUDIES OF VANADIUM COMPOUNDS FROM BOSCAN CRUDE OIL

W. A. SPENCER, J. A. GALOVARDES, M. A. CURTIS, and L. B. ROGERS Aug. 1981 42 p refs (Contract DE-AS09-76ER-00854) (DE82-000977; DOE/ER-00854/32) Avail: NTIS HC A03/MF A01

Vanadium-non-porphyrins were fractionated. Using graphite furnace atomic absorption, the signal for vanadium was found to follow the uv absorption of the chromatogram. In addition, a simpler, faster procedure was devised to isolate a vanadium porphyrin fraction that was more nearly free from both vanadium non-porphyrins and nickel porphyrins. Pyrolysis/GC with both the flame photometric (sulfur) detector and the flame ionization detector gave evidence for a variety of sulfur species in both the porphyrin and non-porphyrin fractions. DOE

### N82-22337# Burns and Roe, Inc., Woodbury, N. Y. ASSESSMENT OF ATMOSPHERIC FLUIDIZED-BED COMBUSTION RECYCLE SYSTEMS Final Report

R. ROGALI, J. WYCKI, and S. KURSMAN Oct. 1981 159 p refs (Contract EPRI PROJ. 1180-1) (DE82-900879; EPRI-CS-2091) Avail: NTIS HC A08/MF A01

A technical and economic evaluation of AFBC power plants with recycle systems, and a comparison of these plants with AFBC power plants with carbon burnup beds (CBB) and with pulverized coal fired power plants with flue gas desulfurization systems are presented. One thousand MWe plants burning both eastern and western coals are considered. The economic analyses are based on a plant located in the east central region of the United States with a 30 year life and a 70 percent capacity factor. The eastern coal fired plants are designed to burn Illinois bituminous coal with a higher heating value of 10,100 Btu/lb and a sulfur content of 4%. The required calcium to sulfur mole ratios for the eastern plants are 3.8:1 and 2.5:1 for the AFBC/CBB and AFBC/recycle plants, respectively. The western coal fired plants are designed to burn Wyoming subbituminous coal with a higher heating value of 8,020 Btu/lb and a sulfur content of 0.48%. The required calcium to sulfur mole ratios for the western plants are 0.7:1 and 0.4:1 for the AFBC/CBB and AFBC/recycle plants, respectively. DOE

**N82-22339#** Institut fuer Erdoelforschung, Hanover (West Germany).

**SECONDARY RECOVERY: CHANGING OF THE VISCOSITY AND COMPRESSIBILITY OF MINERAL OILS WITH DISSOLVED GAS Final Report, Jun. 1981**

E. KUSS and H. KILLESREITER Bonn Bundesministerium fuer Forschung und Technologie Dec. 1981 64 p refs In GERMAN; ENGLISH summary Sponsored by Bundesministerium fuer Forschung und Technologie (BMFT-FB-T-81-225; ISSN-0340-7608) Avail: NTIS HC A04/MF A01; Fachinformationszentrum, Karlsruhe, West Germany DM 13,40

The viscosity of selected oils, i.e. paraffinic oil, naphthene based distillate, and solvent extract, was measured with a capillary viscometer in dependence of pressure, temperature, and the mole fraction of dissolved gases N<sub>2</sub>, CO<sub>2</sub>, CH<sub>4</sub>, and C<sub>3</sub>H<sub>8</sub>. The results show decreasing viscosity with increasing gas concentration that amounts to nearly three orders of magnitude, using propane. Apart from absolute values of the viscosity, the general form of the curve for saturated isotherms in dependence of pressure is determined only by the gas and not by the oil. This facilitates estimations as with the model substances squalane and squalene. A high pressure piezometer for gas/oil solutions provides further interpretation of solubility isotherms. Author (ESA)

**N82-22340#** Grosskraftwerk A.G., Mannheim (West Germany). **STUDY PROJECT ON THE DESULFURIZATION OF FLUE GAS, USING THE BERGBAUFORSCHUNG (BF) PROCESS, AS PART OF THE INTEGRATED OPERATION OF A POWER PLANT WITH A CHEMICAL PLANT FOR PRODUCING SULFURIC ACID Final Report, May 1981**

H. REOSNER and M. OED Bonn Bundesministerium fuer Forschung und Technologie Dec. 1981 36 p refs In GERMAN; ENGLISH summary Sponsored by Bundesministerium fuer Forschung und Technologie (BMFT-FB-T-81-229; ISSN-0340-7608) Avail: NTIS HC A03/MF A01; Fachinformationszentrum, Karlsruhe, West Germany DM 7,60

The BF process for the desulfurization of flue gas was investigated and improved. Operation of a prototype plant and of a demonstration plant, which was added onto a coal fired power plant, is described. Without cooling the flue gas, and using modified desorption at the demonstration plant, the BF process provides SO<sub>2</sub> rich gas as an intermediate product that can be further processed into liquefied SO<sub>2</sub> or into H<sub>2</sub>SO<sub>4</sub>. Production of H<sub>2</sub>SO<sub>4</sub> by integrating chemical works into the power plant complex was followed up and is found cost feasible. The SO<sub>2</sub> liquefaction scheme was not pursued. Any treatment of the enriched gas requires scrubbing. A waste treatment method that supplies a final product with good storage characteristics, after adding calcium hydroxide, is suggested. Author (ESA)

**N82-22374#** Wisconsin Agri-Energy Corp., Meguon. **FEASIBILITY STUDY 20-MM GAL/YR FUEL GRADE ETHANOL FACILITY**

Jun. 1981 141 p refs (Contract DE-FG07-80RA-50392) (DE82-002606; DOE/RA-50392/T1) Avail: NTIS HC A07/MF A01

Results of a preliminary process design and economic study of 20MM US gallons per year fuel grade anhydrous ethanol plant and an associated coal fired cogeneration facility are presented. The process was based on the use of No. 2 US yellow corn as the feedstock and a Wyoming low sulfur coal as the fuel. Distillers dried grains will be recovered as a by-product of the process. It is projected that approximately 80,000 tons of distillers dried grains will be recovered per year. The cogeneration portion will use 115,000 tons of coal a year to produce 115,000 pounds per hour of process steam while at the same time generating 13,300 kilowatts of electricity. The capital cost is estimated to be \$87,504,000. Assessment of the environmental, health, safety, and socioeconomic impacts show that no significant adverse impacts are anticipated in conjunction with either facility construction or

operation. Two air quality considerations require further study.

DOE

**N82-22375#** Pace Co. Consultants and Engineers, Inc., Denver, Colo.

**CORN TO ETHANOL PLANT FEASIBILITY STUDY**

Feb. 1981 507 p Prepared for Grand American, Inc., Yuma, Colo.

(Contract DE-FG07-80RA-50311)

(DE82-000029; DOE/RA-50311/T1) Avail: NTIS HC A22/MF A01

The technical and economic feasibility of a corn to fuel grade ethanol plant in Colorado was assessed. The results indicate that the Grand American project is commercially viable both from an economic and technical standpoint. The results of the economic and risk analysis show a 32.7 percent rate of return based on present state and federal fuel tax exemption legislation. The plant design is based on Raphael Katzen technology which has been used for several years in existing ethanol facilities. Pace does not foresee any technical problems with the facility. Markets for the ethanol appear to be the least secure aspect of the project at this point, although demand is expected to sufficiently increase to provide ample markets. The byproduct market for the dried distillers grains appears to be supply limited. Raw materials for plant operation, including corn, power, water, and coal are readily available. DOE

**N82-22378#** National Grain Corp., Walnut Creek, Calif.

**FEASIBILITY STUDY FOR 400,000 GAL/DAY ETHANOL PLANT AT BENICIA, CALIFORNIA, VOLUME 1**

Jul. 1981 387 p Prepared in cooperation with Western Concentrates, Inc. 3 Vol.

(Contract DE-FG07-80RA-50309)

(DE82-002608; DOE/RA-50309/T1-VOL-1) Avail: NTIS HC A17/MF A01

Results of a study to investigate the feasibility of constructing a 400,000 gal/day (132 million gal/y) ethanol plant in the San Francisco Bay Area are summarized. The main objective was to determine whether and under what conditions the proposed plant could be built and operated with a prospective financial return justifying the investment. Specifically, the study set out to: define markets and prices for ethanol and all byproducts; define feedstock supplies and costs and determine utility and other raw material requirements; solve energy (fuel) supply problems and define an optimum system for generating process heat; complete a preliminary design package; define ways to minimize environmental problems and define an approach to permitting; perform an economic analysis of the plant and investigate economic sensitivities; and develop a financing and management plan for the project. DOE

**N82-22380#** National Grain Corp., Walnut Creek, Calif.

**FEASIBILITY STUDY FOR 400,000 GAL/DAY ETHANOL PLANT AT BENICIA, CALIFORNIA. VOLUME 3. ENVIRONMENTAL REPORT**

Jul. 1981 102 p refs Prepared in cooperation with Western Concentrates, Inc. 3 Vol.

(Contract DE-FG07-80RA-50309)

(DE82-002610; DOE/RA-50309/T1-VOL-3) Avail: NTIS HC A06/MF A01

The technical and economic feasibility of constructing and operating a 400,000 gallon-per-day ethanol plant in Benicia, California was studied. The environmental effects and regulatory aspects of the project are addressed. Mitigation measures which can reduce effects to acceptable levels were assessed. The likelihood and timing of obtaining the permits and approvals necessary were evaluated and problems associated with the project were identified. DOE

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**N82-22385#** Vereinigte Elektrizitaetswerke Westfalen A.G., Dortmund (West Germany).

**CONSTRUCTION OF A 15 T/HR PROTOTYPE PLANT FOR THE VEW COAL CONVERSION PROCESS Final Report, Feb. 1981**

D. DEGGIM and R. KARGER Bonn Bundesministerium fuer Forschung und Technologie Dec. 1981 71 p refs In GERMAN; ENGLISH summary Sponsored by Bundesministerium fuer Forschung und Technologie (BMFT-FB-T-81-216; ISSN-0340-7608) Avail: NTIS HC A04/MF A01; Fachinformationszentrum, Karlsruhe, West Germany DM 12,20

A 15t/hr prototype power plant was built in order to demonstrate the constructibility and operational efficiency of the VEW coal conversion process, after more than 5 years successful operation of a 1t/hr pilot plant. The prototype plant has a stone coal throughput of 15t/hr. It includes the most important units of the VEW coal conversion process, i.e., gasification unit, gas cleaning unit, and steam and power generation units. The gasification unit performs the operations: coal milling and drying, gasification and waste heat recovery, air preheating and gas cokes separation. The gas cleaning unit performs gas cooling and dust recovery, H<sub>2</sub>S-removal, salt splitting and evaporation. The gasification and gas cleaning sections are downstream, followed by a steam boiler, where the generated products are burnt. Simultaneously produced steam is processed in a steam turbine. Author (ESA)

**N82-22604\*#** Instituto de Pesquisas Espaciais, Sao Jose dos Campos (Brazil).

**INFLUENCE OF THE CARRYING VEHICLE IN THE AEROSPATIAL SURVEY OF NATURAL RADIOACTIVITY [INFLUENCIA DO VEICULO PORTADOR NO LEVANTAMENTO AEROSPACIAL DA RADIATIVIDADE NATURAL]**

N. DEJESUSPARADA, Principal Investigator and I. M. MARTIN Sep. 1981 19 p refs In PORTUGUESE Submitted for publication Sponsored by NASA ERTS (E82-10169; NASA-CR-168592; NAS 1.26:168592; INPE-2203-PRE/019) Avail: NTIS HC A02/MF A01 CSCL 08G

The importance of the choice of the carrying vehicle in aerial surveys of natural radioactivity, particularly in the location of uraniferous regions, is discussed. The results of observations depend on the exposure time, that is, the velocity and altitude the carrying vehicle can attain. Overflights of the same region using identical instrumentation but in two different types of aircraft were performed. A detailed statistical analysis of the measurements obtained during these flights demonstrates the precision of localization achievable by this method. Author

**N82-22631\*#** Jet Propulsion Lab., California Inst. of Tech., Pasadena.

**HEALTH AND SAFETY EVALUATION OF A MODIFIED TUNNEL BORER DESIGN FOR APPLICATION TO SINGLE ENTRY COAL MINE DEVELOPMENT**

W. F. ZIMMERMAN 15 Feb. 1982 125 p refs (Contract NAS7-100; DE-AI01-76ET-12548) (NASA-CR-168807; JPL-PUB-82-12; NAS 1.26:168807; DOE/ET-12548/11) Avail: NTIS HC A06/MF A01 CSCL 08I

A health and safety analysis of a single entry coal tunnel borer system is given. The results of the health analysis indicated that while the tunnel borer design offered improvements in dust control through the use of water sprays, a higher face ventilation rule, and the application of spalling rather than the conventional grinding process, it interjected an additional mutagen and toxic compound into the environment through the use of shotcrete. The tunnel borer system easily conformed with the prescribed fatality limit, but exceeded the required limits for disabling and overall injuries. It also exhibited projected disabling and overall injury rates considerably higher than existing continuous mining injury rates. Consequently, the tunnel borer system was not considered an advanced system. R.J.F.

**N82-22632\*#** Jet Propulsion Lab., California Inst. of Tech., Pasadena.

**EVALUATION OF ADAM/1 MODEL FOR ADVANCED COAL EXTRACTION CONCEPTS**

G. K. DESHPANDE and M. D. GANGAL 15 Jan. 1982 26 p refs (Contract NAS7-100; DE-AI01-76ET-12548) (NASA-CR-168812; JPL-PUB-82-21; NAS 1.26:168812; DOE/ET-12548/12) Avail: NTIS HC A03/MF A01 CSCL 08I

Several existing computer programs for estimating life cycle cost of mining systems were evaluated. A commercially available program, ADAM/1 was found to be satisfactory in relation to the needs of the advanced coal extraction project. Two test cases were run to confirm the ability of the program to handle nonconventional mining equipment and procedures. The results were satisfactory. The model, therefore, is recommended to the project team for evaluation of their conceptual designs. R.J.F.

**N82-22634#** Paraho Development Corp., Grand Junction, Colo. **PARAHO OIL SHALE MODULE. CRITICAL ITEMS IDENTIFICATION, TASK 11**

Oct. 1981 39 p 2 Vol. (Contract DE-FC03-80ET-14103) (DE82-003727; DOE/ET-14103/T2) Avail: NTIS HC A03/MF A01

A critical item in the demonstration plant is one that has a notable impact on plant performance. Generally, these items required that decisions be made throughout the course of the Phase I work to facilitate design work and preparation of estimates. The approach taken in each case represents the engineer's best judgement, based on both experience and timely evaluations. Certain critical items were identified as important enough to justify formal trade-off studies to document the alternatives considered and to justify explicitly the selected design. The critical items addressed during the Phase I work are summarized. Both the critical items and the area of performance affected are covered. A brief description of each critical item is presented including: mine and process shale areas; above ground process areas; and environmental and resource areas. DOE

**N82-22638#** Ruhrgas A.G., Essen (West Germany).

**TESTING THE SHEARER-LOADER EDW 170/200 LN FOR THIN SEAMS IN CONNECTION WITH CHAINLESS HAULAGE Final Report**

J. TEGENTHOFF and K. H. KLIMEK Bonn Bundesministerium fuer Forschung und Technologie Jan. 1982 28 p In GERMAN; ENGLISH summary Sponsored by Bundesministerium fuer Forschung und Technologie (BMFT-FB-T-82-017; ISSN-0340-7608) Avail: NTIS HC A03/MF A01; Fachinformationszentrum, Karlsruhe, West Germany DM 5,50

Coal extraction by cutting was investigated. A low clearance machine design was tested. To decrease average seam thicknesses, a system able to operate in a seam aperture of approximately 1.7 m was needed. Maximum possible clearance above the machine was sought, while maintaining sufficient clearance underneath the machine for haulage. A machine height of 855 mm with underbody clearance of 475 mm was achieved. The drive performance and traction force of the winch require improvement. For better utilization of machine potential, a rotational angle should be adapted to the positioning of the drum cutters. Author (ESA)

**N82-22782#** Idaho National Engineering Lab., Idaho Falls. **GEOHERMAL SOURCE POTENTIAL AND UTILIZATION FOR ALCOHOL PRODUCTION**

J. C. AUSTIN Nov. 1981 71 p (Contract DE-AC07-76ID-01570) (DE82-003801; EGG-2138) Avail: NTIS HC A04/MF A01

A study was conducted to assess the technical and economic feasibility of using a potential geothermal source to drive a fuel grade alcohol plant. Test data from the well at the site indicated that the water temperature at approximately 8500 feet should

approach 2750 F. However, no flow data was available, and so the volume of hot water that can be expected from a well at this site is unknown. Using the available data, numerous fuel alcohol production processes and various heat utilization schemes were investigated to determine the most cost effective system for using the geothermal resource. The study found the direct application of hot water for alcohol production based on atmospheric processes using low pressure steam to be most cost effective. It was determined that a 3 million gpy alcohol plant is the largest facility that can practically be powered by the flow from one large geothermal well. DOE

## **N82-22783# Idaho National Engineering Lab., Idaho Falls. POTENTIAL GEOTHERMAL ENERGY APPLICATIONS FOR IDAHO ELKS REHABILITATION HOSPITAL**

J. C. AUSTIN Nov. 1981 14 p  
(Contract DE-AC07-76ID-01570)  
(DE82-003803; EGG-2139) Avail: NTIS HC A02/MF A01

Several potential applications of geothermal energy for the Idaho Elks Rehabilitation Hospital are outlined. A brief background on the resource and distribution system, is provided; which hospital heating systems should be considered for potential geothermal retrofit is discussed; and technical and economic feasibility are addressed. DOE

## **N82-22831# National Mechanical Engineering Research Inst., Pretoria (South Africa). Geomechanics Div. COAL SEAM EXPLORATION WITH SPECIAL REGARD TO THE APPLICATION OF SEISMIC METHODS FOR THE DETECTION OF DYKES**

W. N. MERTEN Jul. 1981 16 p refs  
(CSIR-ME-1721; ISBN-0-7988-14810) Avail: NTIS HC A02/MF A01

The application of in seam seismic methods for coal seam exploration in connection with longwall mining is evaluated. The present exploration practice is reviewed. With the introduction of the relatively expensive high production longwall mining technique, in seam seismic methods are important to successful mining operations. The basics of relevant seismic methods are described, and a research outline is suggested. A detection of dykes is presented as a preliminary emphasis. S.L.

## **N82-22834# Kentucky Univ., Lexington. Inst. for Mining and Minerals Research. PETROGRAPHIC CHARACTERIZATION OF KENTUCKY COALS Annual Report**

J. C. HOWER, J. C. FERM, J. C. COBB, E. J. TRINKLE, K. A. FRANKIE, and S. H. POE 29 Sep. 1981 19 p refs  
(Contract DE-FG62-80PC-30223)  
(DE82-000411; DOE/PC-30223/T2) Avail: NTIS HC A02/MF A01

The petrography of Kentucky coal was studied. Semi-inert macerals, spectral fluorescence of liptinites, and pyrite size/form/microlithotype distribution are investigated. DOE

## **N82-22989# Energy and Minerals Research Co., Exton, Pa. ULTRASONICALLY ENHANCED SIZE REDUCTION OF COAL Quarterly Technical Progress Report, 25 Jun. - 25 Sep. 1981**

W. B. TAPLEY, JR. and H. M. STEPHEY Oct. 1981 14 p  
(Contract DE-AC22-81PC-42268)  
(DE82-001601; DOE/PC-42268/T1; QTPR-1) Avail: NTIS HC A02/MF A01

The beneficial effects of ultrasonic coal comminution on a controlled laboratory scale, grinding selectivity and power requirements are discussed. The experimental work is shown that: (1) energy efficiency can be improved; (2) abrasive wear on the system will be reduced; (3) preferential fracture will reduce product size extremes; (4) and selective fracture may allow harder inclusions (ash and pyrites) to remain unaltered for easing screening. DOE

## **N82-23282\* National Aeronautics and Space Administration. Pasadena Office, Calif. CRUDE OIL DESULFURIZATION Patent**

J. J. KALVINSKAS (California Inst. of Technology, Pasadena), G. C. HSU (California Inst. of Technology, Pasadena), and J. B. ERNEST, inventors (to NASA) (California Inst. of Technology, Pasadena) 12 Jan. 1982 4 p Filed 17 Apr. 1979 Sponsored by NASA

(NASA-CASE-NPO-14542-1; US-PATENT-4,310,049;  
US-PATENT-APPL-SN-030831; US-PATENT-CLASS-166-267;  
US-PATENT-CLASS-166-303; US-PATENT-CLASS-208-241)  
Avail: US Patent and Trademark Office CSCL 07D

High sulfur crude oil is desulfurized by a low temperature (25-80 C.) chlorinolysis at ambient pressure in the absence of organic solvent or diluent but in the presence of water (water/oil=0.3) followed by a water and caustic wash to remove sulfur and chlorine containing reaction products. The process described can be practiced at a well site for the recovery of desulfurized oil used to generate steam for injection into the well for enhanced oil recovery. Author

## **N82-23286# Pittsburgh Energy Technology Center, Pa. Combustion Technology Div. SMALL-SCALE COMBUSTION TESTING OF SYNTHETIC FUELS**

G. A. GIBBON, J. M. EKMANN, C. M. WHITE, R. J. NAVADASKAS, J. I. JOUBERT, and H. L. RETCOFSKY Nov. 1981 21 p refs  
(DE82-002791; DOE/PETC-TR-82/1) Avail: NTIS HC A02/MF A01

In order to assess the possible environmental impact of substituting synfuels for petroleum in utility and industrial boilers, two experimental programs have been undertaken at the Pittsburgh Energy Technology Center. First, a fully instrumented 20 hp firetube boiler capable of burning liquid fuels ranging in combustion characteristics from No. 2 to No. 6 petroleum has been installed in the Combustion Division. Second, a sampling and analytical methodology for the organic compounds present in the exhaust duct of the 20 hp boiler is being developed by the Analytical Chemistry Division. This report outlines the progress on this project to date: twenty-four successful combustion runs were completed on the 20 hp boiler, using a variety of petroleum based fuels and synfuels and a sampling protocol for organic vapors in hot exhaust gases was developed. Significant differences in the composition of the trace organics in the exhaust gases were observed as a function of the fuel being burned, but total polynuclear aromatic hydrocarbon levels are comparable for all fuels. DOE

## **N82-23287# Utah Univ., Salt Lake City. Biomaterials Profiling Center. CHARACTERIZATION OF ROCKY MOUNTAIN COALS AND COAL LIQUID BY COMPUTERIZED ANALYTICAL TECHNIQUES Annual Progress Report**

H. L. C. MEUZELAAR, G. R. HILL, J. H. FUTRELL, A. M. HARPER, D. J. IWAMOTO, D. L. POPE, G. S. METCALF, and J. H. TOMLINSON 1981 72 p refs  
(Contract DE-FG22-80PC-30242)  
(DE82-001802; DOE/PC-30242/T1; APR-1) Avail: NTIS HC A04/MF A01

Over 100 Rocky Mountain coal samples were selected and analyzed by pyrolysis mass spectrometry (MS). Computerized pattern recognition permitted the successful reduction and evaluation of the mass data base generated (over 100,000 mass peak intensities) and revealed strong clustering tendencies of pyrolysis patterns. The pyrolysis mass spectra show strong rank effects allowing complete differentiation between HVCB and HVBB coals partial differentiation both between subbituminous and HVCB samples and between HVBB and HVAB samples. Besides rank effects, marked differences are frequently found between samples from different coal regions, fields or even seams. The high degree of similarity observed between the pyrolysis mass spectra of samples from the same coal seam demonstrates that the combined uncertainties in sample collection, preparation and analysis are

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much smaller than the chemical differences detected by the pyrolysis MS methodology. DOE

**N82-23294#** New Mexico Univ., Albuquerque.  
**PHOTOASSISTED ELECTROLYSIS APPLIED TO COAL GASIFICATION Quarterly Report, 1 Jul. - 30 Sep. 1981**  
S. M. PARK 1981 44 p refs  
(Contract DE-AC21-81MC-16377)  
(DE82-000224; DOE/MC-16377/T1) Avail: NTIS HC A03/MF A01

A literature search and study of coal oxidation mechanisms at noble metal electrodes were made. Ground work on photoassisted electrolysis of coal at the semiconductor thin film electrode was begun by preparing and characterizing n-SnO<sub>2</sub> electrodes. It was concluded that coal is oxidized catalytically by iron(III), which in turn is reduced to iron(II). The iron(II) generated from this catalytic reaction undergoes the electrochemical oxidation, completing a cycle. The rate for this catalytic reaction is determined to be approximately (3.0 for 1.0) times 100,000 sec(+1) for iron(III) and 12,000 sec(+1) for Ce(IV) at 200 C, respectively. M.D.K.

**N82-23326#** Westinghouse Electric Corp., Madison, Pa. Synthetic Fuels Div.  
**WESTINGHOUSE COAL-GASIFICATION COMBINED-CYCLE PRELIMINARY PLANT EVALUATION FOR ELECTRIC-UTILITY APPLICATIONS Final Report, 30 Sep. 1979 - 30 Jun. 1981**  
F. GIGLIOTTI, R. M. STAVSKY, R. CHETTY, R. GARLAND, R. BENGE (Dravo Corp.), and F. KRAHULIK (Dravo Corp.) 30 Jun. 1981 133 p refs  
(Contract DE-AC01-79ET-14672)  
(DE82-002701; DOE/ET-14672/T1) Avail: NTIS HC A07/MF A01

An evaluation design study for electric utility application is presented. Process descriptions, cost estimates and flow diagrams are based on a plant configuration incorporating an air-blown fluidized bed gasification system, a combustion turbine system, and a reheat steam turbine system for the bottoming cycle. Scoping evaluations indicated that a plant capacity of approximately 650 megawatts electric net represents an appropriate plant size from an efficiency, as well as from a utility, point of view. Various cases are analyzed to determine the effect of plant configuration and equipment on the overall plant heat rate and annual bus bar costs. A heat rate of 8340 Btu per kilowatt hour is projected for a plant case that fully integrates the power cycle with the entire gasification process and assumes that 10000 F superheated steam is generated in the gasifier raw gas heat exchanger area. Other cases reflecting less integration and lower superheated steam conditions are also presented. Heat rates and economics of conventional coal fired steam plants with stack gas scrubbers are provided for comparison. The system is projected to have efficiency and economic advantages over a conventional coal fired steam plant with stack gas scrubbers. DOE

**N82-23327#** California Univ., Livermore. Lawrence Livermore Lab.  
**PROCESS FOR UNDERGROUND GASIFICATION**  
R. I. ANTONOVA and E. V. KREININ Aug. 1981 18 p Transl. into ENGLISH of Belgian Patent no. 840,283 (1 Oct. 1976)  
(Contract W-7405-ENG-48)  
(DE82-000493; UCRL-TRANS-11720) Avail: NTIS HC A02/MF A01

An underground coal gasification process to obtain a gas having the maximum heat of combustion and to provide the capability for controlling the process is described. The underground gasification consists of a prior drainage and a gasification of a coal seam by bringing a blowing agent to the incandescent surface of the coal by means of blow holes, and vacuating the gasification products by means of a system of gas evaluation holes. The rate of the indicated gasification of the coal seam is determined as a function of natural conditions. DOE

**N82-23329#** Rockwell International Corp., Canoga Park, Calif. Energy Systems Group.

**COAL-HYDROGASIFICATION PROCESS DEVELOPMENT, GOVERNMENT FISCAL YEAR 1981 Annual Technical Progress Report**

L. P. COMBS, D. HEISTER, M. D. SCHUMAN, N. J. PATEL, M. P. GAREY, and W. T. LEE 20 Oct. 1981 170 p refs  
(Contract DE-AC01-78ET-10328)  
(DE82-004146; DOE/ET-10328/36; ATPR-3) Avail: NTIS HC A08/MF A01

Work performed on a coal hydrogasification process development project is described. Limited progress was made on construction of a coal feed rate integrated process development unit (IPDU) facility for conducting continuous hydrogasification tests of up to 30 days duration. A chemical kinetic model of coal particle hydrolysis was expanded to account for hydroconversion to a generic state of gaseous and liquid products, and this model was then used to correlate successfully carbon conversion results measured in previous flash hydrolysis experiments with both Kentucky No. 9 bituminous and Montana Rosebud subbituminous coals. Subsequently, that coal pyrolysis model was utilized to improve an earlier computerized model for entrained flow fluidized bed processor (FHP) coal conversion reactors. The improved model's predictions were checked against experimental conversion results and other data from 25 tests in the bituminous coal FHP data base with satisfactory agreements. Predesign process optimization and subsystem evaluations were completed. materials surveillance activities in support of the IPDU system were mainly concerned with obtaining archive specimens and data from components being fabricated, accumulating samples of alternative materials to be exposed during IPDU monitoring of key components. DOE

**N82-23330#** Mobay Chemical Corp., Pittsburgh, Pa.  
**FEASIBILITY STUDY OF MEDIUM BTU COAL GAS FOR FUEL AND FEEDSTOCK AT MOBAY'S NEW MARTINSBURG, WEST VIRGINIA PLANT**  
Nov. 1981 130 p  
(Contract DE0-FG01-80RA-50138)  
(DE82-004321; DOE/RA-50138/1) Avail: NTIS HC A07/MF A01

The use of a coal gasification process to produce medium Btu fuel gas and feedstock at Mobay's New Martinsville, West Virginia chemical plant was investigated. Using Ohio River Valley coal, the plant was designed to produce a chemical feedstock containing 93% pure H<sub>2</sub> gas at the rate of 8,900,000 SCFD and 97.5% pure CO at a rate of 2,919,000 SCFD and a medium synthesis gas at the rate of 83,056,300 SCFD. The medium Btu synthesis gas has a heating value of 291 Btu/SCF and will be used for firing existing steam boilers. DOE

**N82-23331#** Miami Univ., Coral Gables, Fla. Dept. of Mechanical Engineering.

**CHARACTERIZATION OF ALCOHOL/GASOLINE BLENDS AS AUTOMOTIVE FUEL: PERFORMANCE AND EMISSIONS CHARACTERISTICS**

R. R. ADT, JR., K. A. CHESTER, M. HARRENSTIEN, C. N. KURUCZ, J. PAPPAS, S. RAJAN, K. T. RHEE, W. F. SPURNY, and M. SWAIN Sep. 1981 322 p refs  
(Contract DE-AS05-76CS-55216)  
(DE82-000124; DOE/CS-55216/T1) Avail: NTIS HC A14/MF A01

The feasibility of using alcohol blends as a motor vehicle fuel is studied. The effect of methanol blends on the performance and regulated emissions characteristics of a conventional, carburetted, multicylinder, automotive type engine and the effect of ethanol blends on the above mentioned performance and emission characteristics using the previously described engine are investigated. Denaturant effects on ethanol blend fueled engine performance and regulated emissions characteristics for the engine are also considered. The effect of methanol blends on the lean misfire limit, and a discussion concerning geometric distribution (in the conventional engine) are presented. DOE

**N82-23336#** Systems Science and Software, La Jolla, Calif.  
**COMPUTER MODELING OF COAL-GASIFICATION REACTORS.**  
**VOLUME 1: EXECUTIVE SUMMARY** Final Report, Jun. 1975 - Nov. 1980

P. J. CHEN, G. P. SCHNEYER, E. W. PETERSON, T. R. BLAKE, J. L. COOK, and D. H. BROWNELL, JR. Apr. 1981 73 p refs (Contract DE-AC21-76ET-10242)

(DE82-000768; DOE/ET-10242/T1-VOL-1; FE-1770-75-VOL-1; SSS-R-81-4814-VOL-1) Avail: NTIS HC A04/MF A01

A five-year effort to study the computer modeling of coal gasification reactors is summarized. General computer models were developed to simulate fluidized bed and entrained flow coal gasification reactors. Subsequently, they were used to simulate actual reactor environments and the resulting compared with the experimental data. An executive summary, a technical report describing the formulations and the applications of the computer models. User's Manuals for, respectively, the fluidized bed model and the entrained flow model are presented. DOE

**N82-23337#** Systems Science and Software, La Jolla, Calif.  
**COMPUTER MODELING OF COAL-GASIFICATION REACTORS.**  
**VOLUME 2: TECHNICAL REPORT** Final Report, Jun. 1975 - Nov. 1980

G. P. SCHNEYER, E. W. PETERSON, P. J. CHEN, J. L. COOK, D. H. BROWNELL, JR., and T. R. BLAKE Apr. 1981 143 p refs

(Contract DE-AC21-76ET-10242)

(DE82-009767; DOE/ET-10242/T1-VOL-2; PE-1770-75-VOL-2; SSS-R-81-4826-VOL-2) Avail: NTIS HC A07/MF A01

The theories and numerical formulations used in developing transient, multidimensional numerical models of both fluidized bed and the entrained flow coal gasification reactors are described. The applications of two developed computer models to the simulation of actual reactor processes are discussed. Results of these computer simulations are compared with available experimental data. DOE

**N82-23338#** Systems Science and Software, La Jolla, Calif.  
**COMPUTER MODELING OF COAL-GASIFICATION REACTORS.**  
**VOLUME 3: USER'S MANUAL OF CHEMFLUB: A NUMERICAL MODEL FOR FLUIDIZED BED GASIFIERS (PLANAR AND AXISYMMETRIC VERSIONS)** Final Report, Jun. 1975 - Nov. 1980

P. J. CHEN Apr. 1981 126 p refs 4 Vol.

(Contract DE-AC21-76ET-10242)

(DE82-000766; DOE/ET-10242/T1-VOL-3; FE-1770-75-VOL-3; SSS-R-81-5009-VOL-3) Avail: NTIS HC A07/MF A01

The CHEMFLUB code was designed to provide predictions of the transient, two-phase, reactive flow fields occurring in a fluidized bed coal gasification reactor. CHEMFLUB can be operated in either two dimensional Cartesian (planar) or axisymmetric geometry. The solid particle phase is treated in a Lagrangian manner in order to maintain sharp interfaces around bubbles and at the freeboard while the gas phase is treated using an Eulerian approach. A detailed chemistry model, encompassing both heterogeneous and homogeneous reactions of both combustion and gasification, is included in the model. Thus, the computer model CHEMFLUB incorporates the coupled dynamic effects of the hydrodynamic, thermodynamic, and chemical phenomena which dominate flow in most fluidized bed coal gasifiers. Detailed discussions of the governing equations are given. A summary of the governing differential, and constitutive equations is given and a brief description of the code, including a flow chart, subroutine structure, and dimension parameters as well as a detailed input sequence are presented. DOE

**N82-23339#** Systems Science and Software, La Jolla, Calif.  
**COMPUTER MODELING OF COAL-GASIFICATION REACTORS.**  
**VOLUME 4: OPERATING MANUAL FOR EF (ENTRAINED FLOW COAL GASIFIER) COMPUTER MODEL** Final Report, Jun. 1975 - Nov. 1980

D. H. BROWNELL, JR., J. L. COOK, and G. P. SCHNEYER Apr. 1981 112 p refs 4 Vol.

(Contract DE-AC21-76ET-10242; EX-77-C-01-1770)

(DE82-000765; DOE/ET-10242/T1-VOL-4; FE-1770-75-VOL-4; SSS-R-81-4920) Avail: NTIS HC A06/MF A01

The EF (Entrained Flow) computer code and three auxiliary computer codes encompass, in operational terms, the computer model of entrained flow coal gasification developed by Systems, Science and Software for the Department of Energy. The primary aspects (geometry, hydrodynamics, thermodynamics, chemistry, etc.) of the computer model are encompassed in the EF computer code which, however, uses tabular information previously generated by the three small, auxiliary computer codes; CEST, COEFTAB and PVAPOR. In this users' manual, each of the four computer programs is described in terms of the theoretical background and objective of each program. A list of the subroutines in each program and their purposes, a detailed description of the program input including an example, and a copy of real program output for the same example was presented. DOE

**N82-23340#** Kentucky Univ., Lexington. Economic Services Dept.

**STATUS OF OCCIDENTAL PETROLEUM'S COAL-OIL-MIXTURE PROGRAM: AN INDUSTRIAL-BOILER RETROFIT**

M. E. ALBERT and R. D. BESSETTA 1981 38 p refs Presented at the 20th Ann. Ky. Ind. Coal Conf., Lexington, Ky., 29 Apr. 1981

(DE82-900076; CONF-8104107-12) Avail: NTIS HC A03/MF A01

Conventional coal grinding and blending used for coal-oil-mixture preparation were investigated. Stabilization techniques incorporated in the plant were studied. The economics for the use of COM can provide a savings sufficient to justify the retrofit for the boiler and a ROI on the facility to produce COM. The total cost difference between the cost of oil and the cost to produce COM which includes raw materials and production costs for a straight coal/oil mix with coal pulverized to 80% through 200 mesh was determined. The COM price will be based on a dollar per barrel delivered and adjusted to equivalent oil Btu's on a monthly or quarterly basis. It was concluded that COM is producible, handleable, storable and burnable. Information to minimize retrofit cost and maximize economic savings is available. Coal oil mixtures are ready to contribute dollars to the profit of each COM consuming plant. M.D.K.

**N82-23616#** California Univ., Livermore. Lawrence Livermore Lab.

**OIL SHALE PROJECT RUN SUMMARY LARGE RETORT RUN L-4**

J. H. RALEY, J. H. CAMPBELL, W. A. SANDHOLTZ, F. J. ACKERMAN, R. G. MALLON, L. L. OTT, and J. J. RONCHETTO 5 Nov. 1981 105 p refs

(Contract W-7405-ENG-48)

(DE82-003627; UCID-19238) Avail: NTIS HC A06/MF A01

A simulated MIS experiment was carried out in the 6 metric ton oil shale retort. An oil yield of 87% FA was achieved at a retorting rate of 2.8 to 3.0 m/day with a shale bed of -30 +0.001 cm particle size range and including a nearly two fold step change in grade. Temperature control was maintained by varying the steam/air ratio and injection gas rate. Oil yield, front position and retorting rate, as predicted in real time during the run from offgas data, agreed reasonably well with directly measured counterparts. Pre-run model calculations reliably predicted operating conditions for both inert gas pre-ignition and combustion retorting phases of the run. Pre-run steam logging predicted the degree of horizontal uniformity of the retorting front. Ultrasonic reflectometry, gas releasing capsules and differential pressure measurements were shown to be promising methods for temperature measurement.

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Passage of the retorting front through the grade change was signalled by changes in offgas composition. DOE

**N82-23617#** Pacific Northwest Lab., Richland, Wash.  
**WESTERN OIL SHALE DEVELOPMENT: A TECHNOLOGY ASSESSMENT. VOLUME 1: MAIN REPORT Final Report**  
D. HESSEL and G. STRASSER Nov. 1981 360 p refs  
(Contract DE-AC06-76RL-01830)  
(DE82-003132; PNL-3830-VOL-1) Avail: NTIS HC A16/MF A01

The prospects of shale oil use are discussed within the context of environmental constraints, available natural and economic resources, and the characteristics of existing and emerging technology. Shale oil technologies are reviewed objectively as a means of supplying domestically produced fuels within environmental, social, economic, and legal/institutional constraints. Using available data, analyses, and experienced judgment, the major points of uncertainty regarding potential impacts of oil shale development are examined. Issues which cannot be resolved on the bases of the data, analyses, and experienced judgment currently available are identified. When appropriate and feasible, ways for the removal of existing uncertainties that stand in the way of resolving outstanding issues are suggested. DOE

**N82-23618#** Utah Univ., Salt Lake City. Dept. of Geology and Geophysics.  
**HEAT FLOW AND GEOTHERMAL ASSESSMENT OF THE ESCALANTE DESERT, SOUTHWESTERN UTAH, WITH EMPHASIS ON THE NEWCASTLE KGRA**  
M. D. CLEMENT and D. S. CHAPMAN Feb. 1981 126 p refs  
(Contract DE-AC07-79ID-12079)  
(DE82-003952; DOE/ID-12079/28) Avail: NTIS HC A07/MF A01

Twenty-five regional heat flow measurements are presented for the Escalante Desert region within the Great Basin of the western US. Heat flow excluding geothermal areas ranges from 42 to 350 mW/sq m but much of the variability may be caused by deeply circulating groundwater redistributing the regional flux. A subset of 10 sites drilled specifically to characterize the heat flow of the region yielded a mean of 100 mW/sq m with a standard cylindrical discs and rock chips of rhyolite to andesite tuffs emphasized the importance of porosity corrections to thermal conductivity measurements. A blind geothermal system southwest of Newcastle, Utah, situated within the Escalante Desert was also studied. Heat flow results from 11 local drillholes yield values between 163 and 3065 mW/sq m. The 500 mW/sq m contour encloses an area of 9.4 sq km. By integrating the anomalous flux above background over the thermal anomaly, a thermal power loss of 12.8 mW and corresponding subsurface mass discharge of 32 kg/s are calculated for this geothermal system. DOE

**N82-23619#** Gruy Federal, Inc., Houston, Tex.  
**TARGET RESERVOIRS FOR CO2 MISCIBLE FLOODING. TASK TWO: SUMMARY OF AVAILABLE RESERVOIR AND GEOLOGICAL DATA. VOLUME 1: PERMIAN BASIN GEOLOGICAL AND RESERVOIR DATA, PART 1. PERMIAN BASIN RESERVOIR SELECTION PROCEDURE, GEOLOGY, AND RESERVOIR DATA SUMMARY Final Report**  
L. B. COBB and J. H. GOODRICH Oct. 1981 134 p refs  
Prepared in cooperation with Morgantown Energy Technology Center, W. Va.  
(Contract DE-AC21-79MC-08341)  
(DE82-001349; DOE/MC-08341/31-VOL-1-PT-1) Avail: NTIS HC A07/MF A01

An engineering foundation to serve as the basis for field mini- and pilot tests in both high and low oil saturation carbonate reservoirs for the purpose of extending the technology base in carbon dioxide miscible flooding is presented. Six tasks were studied and are as follows: summary of available CO2 field test data; summary of existing reservoir and geological data; selection of target reservoirs; selection of specific reservoirs for CO2 injection tests; selection of specific sites for test wells in carbonate reservoirs; and drilling and coring activities. DOE

**N82-23620#** Gruy Federal, Inc., Houston, Tex.  
**TARGET RESERVOIRS FOR CO2 MISCIBLE FLOODING. TASK TWO: SUMMARY OF AVAILABLE RESERVOIR AND GEOLOGICAL DATA. VOLUME 1: PERMIAN BASIN GEOLOGICAL AND RESERVOIR DATA; PART 3. FARMER-SAN ANDRES THROUGH NOLLEY-WOLFCAMP Final Report**  
L. B. COBB Oct. 1981 358 p  
(Contract DE-AC21-79MC-08341)  
(DE82-001347; DOE/MC-08341/31-VOL-1-PT-3) Avail: NTIS HC A16/MF A01

A summary of existing reservoir and geological data on carbonate reservoirs located in the Permian basin of west Texas and southeast New Mexico is given. The data may serve as a basis for field mini- and pilot tests in both high and low oil saturation carbonate reservoirs for the purpose of extending the technology base in carbon dioxidemiscible flooding. DOE

**N82-23622#** Pacific Northwest Lab., Richland, Wash. Technology Assessments Div.  
**WESTERN OIL SHALE DEVELOPMENT. A TECHNOLOGY ASSESSMENT Final Report**  
Nov. 1981 31 p  
(Contract DE-AC06-76RL-01830)  
(DE82-003004; PNL-3830-EXEC-SUMM) Avail: NTIS HC A03/MF A01

Shale oil technologies as a means of supplying domestically produced fuels within environmental, social, economic, and legal/institutional constraints are reviewed, using available data, analyses, and experienced judgment, to examine the major points of uncertainty regarding potential impacts of oil shale development. Issues where data and analyses are compelling or where conclusions can be reached on judgmental grounds are resolved and issues which cannot be resolved on the bases of the data, analyses, and experienced judgment currently available are specified. Ways of removing existing uncertainties that stand in the way of resolving outstanding issues are suggested. DOE

**N82-23625#** Western Geophysical Co. of America, Houston, Tex. Aero Service Div.  
**AIRBORNE GAMMA-RAY SPECTROMETER AND MAGNETOMETER SURVEY, KENORA QUADRANGLE, MINNESOTA, VOLUME 1 Final Report**  
Mar. 1981 87 p refs  
(Contract DE-AC13-76GJ-01664)  
(DE82-001029; GJBX-328-81-VOL-1) Avail: NTIS HC A05/MF A01

During the months of June through October, 1980, Aero Service Division Western Geophysical Company of America conducted an airborne high sensitivity gamma-ray spectrometer and magnetometer survey over eleven (11) 20 x 10 NTMS quadrangles located in the states of Minnesota and Wisconsin and seven (7) 20 x 10 NTMS quadrangles in North and South Dakota. The results obtained over the Kenora map area of Minnesota are discussed. The final data are presented in four different forms: on magnetic tape; on microfiche; in graphic form as profiles and histograms; and in map form as anomaly maps, flight path maps, and computer printer maps. DOE

**N82-23635#** Western Geophysical Co. of America, Houston, Tex. Aero Service Div.  
**AIRBORNE GAMMA-RAY SPECTROMETER AND MAGNETOMETER SURVEY. DEVIL'S LAKE QUADRANGLE, NORTH DAKOTA, VOLUME 1 Final Report**  
May 1981 98 p refs 2 Vol.  
(Contract DE-AC13-76GJ-01664)  
(DE82-004161; GJBX-354-81-VOL-1) Avail: NTIS HC A05/MF A01

During the months of June through October, 1980, an airborne high sensitivity gamma ray spectrometer and magnetometer survey was conducted over eleven 20 X 10 NTMS quadrangles located in the states of Minnesota and Wisconsin and seven 20 x 10 NTMS quadrangles in North and South Dakota. The results obtained over the Devil's Lake map area of North Dakota are

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discussed. The final data are presented in four different forms: on magnetic tape; on microfiche; in graphic form as profiles and histograms; and in map form as anomaly maps, flight path maps, and computer printer maps. DOE

**N82-23636#** Western Geophysical Co. of America, Houston, Tex. Aero Service Div.  
**AIRBORNE GAMMA-RAY SPECTROMETER AND MAGNETOMETER SURVEY. DEVIL'S LAKE QUADRANGLE, NORTH DAKOTA, VOLUME 2 Final Report**  
Apr. 1981 98 p 2 Vol.  
(Contract DE-AC13-76GJ-01664)  
(DE82-004168; GJBX-354-81-VOL-2) Avail: NTIS HC A05/MF A01

Volume 2 on airborne gamma ray spectrometer and magnetometer surveys contains the flight path map, radiometric multiple parameter stacked profiles, magnetic and ancillary parameter stacked profiles, histograms, and anomaly maps for uranium, potassium, thorium, uranium/potassium, uranium/thorium, and thorium/potassium. DOE

**N82-23637#** Western Geophysical Co. of America, Houston, Tex. Aero Service Div.  
**AIRBORNE GAMMA-RAY SPECTROMETER AND MAGNETOMETER SURVEY. BEMIDJI QUADRANGLE, MINNESOTA, VOLUME 1 Final Report**  
May 1981 102 p refs 2 Vol.  
(Contract DE-AC13-76GJ-01664)  
(DE82-001032; GJBX-331-81-VOL-1) Avail: NTIS HC A06/MF A01

The results obtained over the Bemidji map area of Minnesota by airborne high sensitivity gamma ray spectrometer and magnetometer surveys are discussed. The final data are presented in four different forms: on magnetic tape; on microfiche; in graphic form as profiles and histograms; and in map form as anomaly maps, flight path maps, and computer printer maps. Complete data listings of both the reduced single record and the reduced averaged record data are also reported. DOE

**N82-23638#** Western Geophysical Co. of America, Houston, Tex. Aero Service Div.  
**AIRBORNE GAMMA-RAY SPECTROMETER AND MAGNETOMETER SURVEY. BEMIDJI QUADRANGLE, MINNESOTA, VOLUME 2 Final Report**  
Mar. 1981 50 p 2 Vol.  
(Contract DE-AC13-76GJ-01664)  
(DE82-001026; GJBX-331-81-VOL-2) Avail: NTIS HC A03/MF A01

Aerial surveys of the Bemidji quadrangle, Minnesota are reported. In volume 2 the flight path map, multiparameter profiles, histograms and anomaly maps for uranium, thorium, potassium, uranium/potassium, uranium/thorium and thorium/potassium are presented. DOE

**N82-23645#** Geological Survey, Champaign, Ill.  
**ANALYSES OF NATURAL GAS IN ILLINOIS**  
W. F. MEENTS 1981 70 p refs Sponsored in part by the Illinois Inst. of Natural Resources  
(PB82-124322; IL/SGS/IP-122) Avail: NTIS HC A04/MF A01 CSCI 08D

By the end of 1979, natural gas samples from 2,321 sources in Illinois were analyzed. Major sources of gas samples and the number of samples from those sources include: solution gas from water wells (1,402), gas wells (412), solution gas from oil wells (166); solution gas from oil-filled water supply wells (142), abandoned coal mine vents (60), gas seeps (38), landfill vents (16), and water springs (16). Several methods were used for analysis: 242 early gas samples were analyzed using the Orsat method; 47 samples were checked on a Podbielniak apparatus; the remaining 2,033 were analyzed by gas chromatography. These data are presented as a computerized data base which should be particularly valuable to geologists and geochemists interested in the occurrence and geologic history of oil and gas, or who wish

to assess the potential hazards to humans of certain gaseous emanations. GRA

**N82-23786#** Great Plains Agricultural Council, Lincoln, Nebr. Committee on Social and Economic Implications of Energy Extraction, Conversion and Transportation  
**NATIONAL INTERREGIONAL COAL MODELS: PROCEEDINGS ON A WORKSHOP**  
J. W. GREEN, ed. Oct. 1981 275 p refs Workshop held in Bozeman, Mont., 26-27 Jul. 1979  
(PB82-120932; GPAC-93; EPA-600/9-80-042) Avail: NTIS HC A12/MF A01 CSCI 10A

The Great Plains Agricultural Council's Committee on Social and Economic Implications of Energy Extraction, Conversion and Transportation (GPC-8) organized and cosponsored with the Old West Regional Commission a Workshop on National Interregional Coal Models in Bozeman, Montana on July 26-27, 1979. Detailed information on six large-scale coal models were presented at the workshop. GRA

**N82-23787#** National Weather Service, Salt Lake City, Utah.  
**PRELIMINARY ESTIMATES OF WIND POWER POTENTIAL AT THE NEVADA TEST SITE**  
H. G. BOOTH Jul. 1981 19 p refs Prepared in cooperation with National Weather Service, Las Vegas, Nev.  
(PB82-127036; NOAA-TM-NWS-WR-166) Avail: NTIS HC A02/MF A01 CSCI 10A

An assessment of the potential for the useful conversion of wind power to electrical power is given for a Nevada test site. Annual wind power availability was estimated to be sufficient. The percentage of low wind hours was found to be high, and the persistence of favorably strong winds for periods of several days at a time was low. There was a pronounced diurnal cycle in wind power availability. It is concluded that baseload electrical power requirements would require alternate energy sources. Cost effectiveness of this configuration would have to be determined. R.J.F.

**N82-23830#** Oklahoma Univ., Norman.  
**SOURCE ROCK GEOCHEMISTRY AND LIQUID AND SOLID PETROLEUM OCCURRENCES OF THE OUACHITA MOUNTAINS, OKLAHOMA Ph.D. Thesis**  
J. A. CURIALE 1981 305 p  
Avail: Univ. Microfilms Order No. 8129427

Crude oils, solid bitumens and potential oil source rocks of the frontal and central Ouachita Mountains of southeastern Oklahoma are examined. The organic matter in each of these materials is characterized, and oils are correlated to potential source rocks in the Ouachita Mountains. Four Ouachita Mountain oils and seven solid bitumens (grahamite and impsomite) are analyzed. The oils are paraffinic and range from 31.8 to 43.1 API gravity. The oils are thermally mature and generally unaltered. All four oils are commonly sourced, by n-alkane, sterane and hopane distributions, stable isotope ratios, infrared spectra and vanadium/nickel ratios. A common source for the solid bitumens is also suggested by isotope ratios and pyrolyzate characteristics. An origin due to crude oil biodegradation is suggested for these solids, based on carbon isotope ratios, elemental analyses, and sterane distributions of the solid bitumen pyrolyzates. Dissert. Abstr.

**N82-23835#** Idaho National Engineering Lab., Idaho Falls.  
**RAFT RIVER GEOSCIENCE CASE STUDY: APPENDIXES**  
M. R. DOLENC, L. C. HULL, S. A. MIZELL, B. F. RUSSELL, P. A. SKIBA, J. A. STRAWN, J. A. TULLIS, and R. GARBER, ed. Nov. 1981 155 p refs 2 Vol.  
(Contract DE-AC07-76ID-01570)  
(DE82-003553; EGG-2125-VOL-2) Avail: NTIS HC A08/MF A01

The lithology, x-ray analysis, cores, and well construction data are presented. Borehole geophysical logs, chemical analyses from wells at the Raft River geothermal site, and a bibliography are included. T.M.

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**N82-23837#** Sandia Labs., Albuquerque, N. Mex. In Situ Technologies Div.

### **EFFECT OF PULSE LOADS ON DYNAMIC ROCK FRACTURE**

E. P. CHEN Oct. 1981 27 p refs

(Contract DE-AC04-76DP-00789)

(DE82-002311; SAND-81-1942) Avail: NTIS HC A03/MF A01

An analytical model was developed which is capable of predicting the fracture pattern in the rock surrounding a wellbore upon which a dynamic loading pulse is applied. The development of the model followed the principle of elastodynamic fracture mechanics. Specifically, inherent cracks are assumed to exist around the edge of the wellbore. Depending on the pulse shape, these cracks are activated to form various fracture patterns. The criterion for initiation of crack growth is determined by the magnitude of the dynamic stress intensity factor associated with the crack. The finite element code HONDO was used to calculate the dynamic stress intensity factors. Analytical predictions were correlated with field experimental data and good agreements were found. DOE

**N82-24123#** California Univ., Berkeley.

### **THERMODYNAMICS OF GEOTHERMAL FLUIDS Ph.D. Thesis**

P. S. Z. ROGERS 1981 249 p

Avail: Univ. Microfilms Order No. 8200253

A model to predict the thermodynamic properties of geothermal brines, based on a minimum amount of experimental data on a few key systems, was tested. Volumetric properties of aqueous sodium chloride, taken from the literature, are represented by a parametric equation over the range 0 C to 300 C and 1 bar to 1 kbar. Density measurements at 20 bar needed to complete the volumetric description also are presented. The pressure dependence of activity and thermal properties, derived from the volumetric equation, were used to complete an equation of state for sodium chloride solutions. A flow calorimeter used to obtain heat capacity data at high temperatures and pressures is described. Heat capacity measurements from 30 C to 200 C and 1 bar to 200 bar are used to derive values for the activity coefficient and other thermodynamic properties of sodium sulfate solutions as a function of temperature. Literature data on the solubility of gypsum in mixed electrolyte solutions was used to evaluate model parameters for calculating gypsum solubility in seawater and natural brines. Predictions of strontium and barium sulfate solubility in seawater are also given. Dissert. Abstr.

**N82-24350#** International Atomic Energy Agency, Vienna (Austria).

### **MOESSBAUER SPECTROSCOPY STUDY ON THE EFFECT OF INFRARED AND GAMMA RADIATION ON THE STRUCTURE OF MINERALS. PART OF COORDINATED PROGRAMME ON DEVELOPMENT OF METHODS FOR APPLICATION OF MOESSBAUER SPECTROSCOPY IN MINERALOGY, SOIL SCIENCES AND THE STUDY OF CERAMICS Final Report, 1 Apr. 1978 - 30 Sep. 1981**

H. POLLAK (National Univ. of Zaire) Aug. 1981 3 p

(DE81-700780; IAEA-R-2174-F) Avail: NTIS (US Sales Only)

HC A02/MF A01; DOE Depository Libraries

A number of fundamental and applied problems were studied by Moessbauer spectroscopy. The observation of Moessbauer spectra in iron silicate deerite with respect to the structure of this mineral was interpreted by charge transfer between iron ions, and correlated with thermally activated electron delocalisation. The studies of local coals showed the suitability of Moessbauer spectroscopy in control of the desulfurization process. A simple method to use Moessbauer measurement to determine the obstructions in water pipes was developed. DOE

**N82-24351#** Committee on Energy and Commerce (U. S. House).

### **FOSSIL AND SYNTHETIC FUELS MISCELLANEOUS, PART 1**

Washington GPO 1981 213 p refs Hearings on H.R. 2166 before the Subcomm. on Fossil and Synthetic Fuels of the Comm. on Energy and Com., 97th Congr., 1st Sess., 26 Feb. 1981

(GPO-84-010) Avail: Subcommittee on Fossil and Synthetic Fuels

The limited antitrust defense available under the Energy Policy and Conservation Act to domestic oil companies participating in an international energy program is discussed. The extension of this antitrust protection beyond March 15, 1982 is considered. An authorization request concerning safety measures to be taken with regard to liquefied natural gas pipelines is discussed. Also discussed is gasohol usage, particularly in government owned motor vehicles. R.J.F.

**N82-24352#** Committee on Science and Technology (U. S. House).

### **DIRECT COMBUSTION OF COAL**

Washington GPO 1982 128 p refs Hearing before the Subcomm. on Energy Develop. and Appl. of the Comm. on Sci. and Technol., 97th Congr., 1st Sess., No. 69, 10 Dec. 1981

(GPO-89-628) Avail: Subcommittee on Energy Development and Applications

The utilization of coal through direct combustion is discussed. The environmental problems associated with coal use and the work being done to alleviate a number of the problems are discussed. Fluidized bed processors are described. Future domestic energy policy is discussed. R.J.F.

**N82-24354#** Southwest Research Inst., San Antonio, Tex. Army Fuels and Lubricants Research Lab.

### **A FIELD MONITOR FOR THE STABILITY AND CLEANLINESS OF DISTILLATE FUEL Interim Report, Oct. 1978 - Sep. 1981**

S. R. WESTBROOK, L. L. STAVICHA, J. G. BARBEE, and J. V. MENGENHAUSER (Army Mobility Equipment Research and Development Command, Ft. Belvoir, Va.) Dec. 1981 56 p refs

(Contract DAAK70-78-C-0001; DAAK70-80-C-0001; DA PROJ.

1L7-62733-AH-20)

(AD-A110694; AFLRL-137) Avail: NTIS HC A04/MF A01

CSCS 14B

This report details the development of a portable device to measure the cleanliness and stability of diesel fuels in both bulk and vehicle fuel cell storage. Both an initial laboratory prototype and a portable field unit are discussed. The monitor evaluates the cleanliness of the fuel by first filtering the fuel and then determining the amount of particulates on the filters using a contaminated filter measuring device. The filters are rated by measuring the amount of light which passes through the filters to estimate the amount of particulates based on a calibration chart. A measure of the stability of the fuel is obtained by aging a sample of the fuel at 150 C for 1.5 hours and determining the amount of sediment formed. Improvements to the diesel fuel quality monitor have been identified and are being investigated. A field test program to demonstrate monitor utility/effectiveness is planned for initiation in late 1981. In addition, a commercially available portable unit to measure particulate contamination is described and compared to the Army field test unit. GRA

**N82-24355#** Southwest Research Inst., San Antonio, Tex. Energy Systems Research Div.

**IMPACT STUDY OF SYNTHETIC AND ALTERNATIVE FUEL USAGE IN ARMY AIRCRAFT PROPULSION SYSTEMS Final Report, Oct. 1980 - Jun. 1981**

C. A. MOSES and M. I. VALTIERRA Jul. 1981 166 p refs Sponsored in part by the Army Mobility Research and Development Command

(Contract N00140-80-C-2269)

(AD-A111046; SWRI-MED134) Avail: NTIS HC A08/MF A01

CSCL 21D

The U.S. Army is concerned about the quality of future aircraft fuels and their compatibility with current engines and aircraft fuel systems. This impact study of synthetic and alternate fuel usage on Army aircraft propulsion and fuel systems addresses four technical areas: (1) The fuel scenario for Army aviation gas turbine fuels; (2) The effects of initial properties or the performance and durability of engine and fuel system components; (3) The identification of engines and fuel system components used in Army aircraft and their interface with the fuel; and (4) A review of qualification and certification procedures. Author (GRA)

**N82-24525\*#** National Aeronautics and Space Administration. Lewis Research Center, Cleveland, Ohio.

**LANDSAT REMOTE SENSING: OBSERVATIONS OF AN APPALACHIAN MOUNTAINTOP SURFACE COAL MINING AND RECLAMATION OPERATION**

Oct. 1979 7 p refs Original contains color imagery. Original photography may be purchased from the EROS Data Center, Sioux Falls, S.D. 57198. Original contains color illustrations ERTS (E82-10247; NASA-TM-84194; NAS 1.15:84194) Avail: NTIS HC A02/MF A01 CSCL 08I

The potential benefits of using LANDSAT remote sensing data by state agencies as an aide in monitoring surface coal mining operations are reviewed. A mountaintop surface mine in eastern Kentucky was surveyed over a 5 year period using satellite multispectral scanner data that were classified by computer analyses. The analyses were guided by aerial photography and by ground surveys of the surface mines procured in 1976. The application of the LANDSAT data indicates that: (1) computer classification of the various landcover categories provides information for monitoring the progress of surface mining and reclamation operations; (2) successive yearly changes in barren and revegetated areas can be qualitatively assessed for surface mines of 100 acres or more of disrupted area; (3) barren areas consisting of limestone and shale mixtures may be recognized, and revegetated areas in various stages of growth may be identified against the hilly forest background. E.A.K.

**N82-24566\*#** Mississippi State Univ., Mississippi State. Remote Sensing Center.

**APPLICATION OF REMOTE SENSING TO STATE AND REGIONAL PROBLEMS Semiannual Progress Report, 1 May - 31 Oct. 1981**

W. F. MILLER, J. R. CLARK, J. L. SOLOMON, B. DUFFY, K. MINCHEW, and L. H. WRIGHT, Principal Investigator 1 Nov. 1981 89 p refs ERTS

(Contract NGL-25-001-054)

(E82-10288; NASA-CR-168857; NAS 1.26:168857; SAPR-16)

Avail: NTIS HC A05/MF A01 CSCL 06B

The objectives, accomplishments, and future plans of several LANDSAT applications projects in Mississippi are discussed. The applications include land use planning in Lowndes County, strip mine inventory and reclamation, white tailed deer habitat evaluation, data analysis support systems, discrimination of forest habitats in potential lignite areas, changes in gravel operations, and determination of freshwater wetlands for inventory and monitoring. In addition, a conceptual design for a LANDSAT based information system is discussed. M.G.

**N82-24649\*#** Parsons (Ralph M.) Co., Pasadena, Calif.

**FUEL QUALITY PROCESSING STUDY, VOLUME 1 Final Report**

J. B. OHARA, A. BELA, N. E. JENTZ, H. T. SYVERSON, H. W. KLUMPE, R. E. KESSLER, H. T. KOTZOT, and B. L. LORAN Apr. 1981 203 p refs 2 Vol.

(Contract DEN3-183; DE-AI01-77ET-13111)

(NASA-CR-165327-VOL-1; DOE/NASA/0183-1; NAS

1.26:165327-VOL-1) Avail: NTIS HC A10/MF A01 CSCL 21D

A fuel quality processing study to provide a data base for an intelligent tradeoff between advanced turbine technology and liquid fuel quality, and also, to guide the development of specifications of future synthetic fuels anticipated for use in the time period 1985 to 2000 is given. Four technical performance tests are discussed: on-site pretreating, existing refineries to upgrade fuels, new refineries to upgrade fuels, and data evaluation. The base case refinery is a modern Midwest refinery processing 200,000 BPD of a 60/40 domestic/import petroleum crude mix. The synthetic crudes used for upgrading to marketable products and turbine fuel are shale oil and coal liquids. Of these syncrudes, 50,000 BPD are processed in the existing petroleum refinery, requiring additional process units and reducing petroleum feed, and in a new refinery designed for processing each syncrude to produce gasoline, distillate fuels, resid fuels, and turbine fuel, JPGs and coke. An extensive collection of synfuel properties and upgrading data was prepared for the application of a linear program model to investigate the most economical production slate meeting petroleum product specifications and turbine fuels of various quality grades. Technical and economic projections were developed for 36 scenarios, based on 4 different crude feeds to either modified existing or new refineries operated in 2 different modes to produce 7 differing grades of turbine fuels. A required product selling price of turbine fuel for each processing route was calculated. Procedures and projected economics were developed for on-site treatment of turbine fuel to meet limitations of impurities and emission of pollutants. R.J.F.

**N82-24650\*#** Parsons (Ralph M.) Co., Pasadena, Calif.

**FUEL QUALITY/PROCESSING STUDY. VOLUME 2: APPENDIX. TASK 1 LITERATURE SURVEY Final Report**

J. B. OHARA, A. BELA, N. E. JENTZ, H. W. KLUMPE, H. E. KESSLER, H. T. KOTZOT, and B. L. LORAN Apr. 1981 274 p refs 2 Vol.

(Contract DEN3-183; DE-AI01-77ET-13111)

(NASA-CR-165327-VOL-2; DOE/NASA/0183-1; NAS

1.26:165327-VOL-2) Avail: NTIS HC A12/MF A01 CSCL 21D

The results of a literature survey of fuel processing and fuel quality are given. Liquid synfuels produced from coal and oil shale are discussed. Gas turbine fuel property specifications are discussed. On-site fuel pretreatment and emissions from stationary gas turbines are discussed. Numerous data tables and abstracts are given. R.J.F.

**N82-24732#** Oak Ridge National Lab., Tenn. Fossil Energy Materials Office.

**FOSSIL-ENERGY MATERIALS PROGRAM Quarterly Progress Report, period ending 30 Jun. 1981**

Sep. 1981 418 p refs

(Contract W-7405-ENG-26)

(DE82-001057; ORNL/FMP-81/3) Avail: NTIS HC A18/MF A01

Research and development on materials for fossil energy applications with a focus on the longer term and generic needs of the various fossil fuel technologies is reported. The program includes research aimed toward a better understanding of materials behavior in fossil energy environments and the development of new materials capable of substantial enhancement of plant operations and reliability. Projects related to a particular fossil energy technology are described. The various projects associated with that technology are outlined. The fossil energy materials program quarterly progress reports series as a dissemination of information which is developed on the program. DOE

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**N82-24775#** California Univ., Berkeley. Lawrence Berkeley Lab. Earth Sciences Div.

### **ASSESSMENT OF PRECISE SURFACE-GRAVITY MEASUREMENTS FOR MONITORING THE RESPONSE OF A GEOTHERMAL RESERVOIR TO EXPLOITATION**

R. B. GRANNELL, J. H. WHITCOMB, P. S. ARONSTAM, and R. C. CLOVER Jun. 1981 112 p refs Prepared in cooperation with California State Univ., Long Beach and Colorado Univ., Boulder

(Contract W-7405-ENG-48)

(DE82-003904; LBL-12910; GSRMP-11) Avail: NTIS HC A06/MF A01

Recommendations for carrying out surveys which achieve 15, 10 and 5 microgal precisions are presented. Twenty geothermal areas in the western United States which might be suitable for precise repetitive gravity monitoring were evaluated. The evaluation criteria included capability for subsidence on a geological basis, estimated electrical production, environmental impact, and anticipation of production in the near future. It is felt that the most promising areas in order of priority are: (1) the Salton Sea field, California; (2) Valles Caldera, New Mexico; (3) the Geysers-Clear Lake; and (4) Westmorland, California; (5) Roosevelt Hot Springs, Utah; and (6) Heber, Brawley, and Long Valley, California. DOE

**N82-25394\*#** National Aeronautics and Space Administration. Pasadena Office, Calif.

### **AUTOCATALYTIC COAL LIQUEFACTION PROCESS Patent Application**

S. A. QADER, Principal Investigator (JPL, California Inst. of Technology, Pasadena) 3 Jan. 1980 32 p Sponsored by NASA

(NASA-CASE-NPO-14876-2; US-PATENT-APPL-SN-285194)

Avail: NTIS HC A03/MF A01 CSCL 21D

An improved process for liquefying coal in which coal minerals at high content are utilized as hydrocracking catalysts is described. A slurry of 10 to 60% by weight of coal in a recycled liquefied coal product containing 15 to 30% by weight of coal minerals is pressurized with excess hydrogen to a pressure of 2,000 to 4,000 psi and heated to a temperature of 450 to 550 degrees C. The coal minerals autocatalytically convert coal solids to a low viscosity liquid product and to a gas product in high yields while reducing oxygen, nitrogen, and sulfur content of the coal product as compared to other coal liquefaction processes under development. NASA

**N82-25396#** Air Force Inst. of Tech., Wright-Patterson AFB, Ohio. School of Systems and Logistics.

### **AN ECONOMIC MODEL OF FUTURE COAL/DENSIFIED REFUSE-DERIVED FUEL USE AT WRIGHT-PATTERSON AFB, OHIO M.S. Thesis**

R. G. FEDORS Sep. 1981 184 p refs

(AD-A11376; AFIT-LSSR-97-81) Avail: NTIS HC A09/MF A01 CSCL 13A

A thirty-month evaluation/demonstration of densified refuse-derived fuel (dRDF) as a stoker boiler fuel in military heating plants was performed. The impact on plant operating expenses of burning coal dRDF mixtures at that particular base is examined. The figures for comparison were generated by a simulation model of the base heating system and environment. Projected yearly operating expenses were accumulated in the model and returned to present values for various fuel ratios, inflation rates, and discount factors. Under the assumptions made within the model, coal alone will remain less expensive to use than a mixture of dRDF until a local source of dRDF becomes available. J.D.

**N82-25399#** General Technology Applications, Inc., Arlington, Va.

### **INVESTIGATION OF THE APPLICATION OF A CRYOGENIC BLENDING PROCESS TO PRODUCE ANTIMISTING DIESEL FUELS Final Report**

A. F. HADERMANN, P. WATERS, J. C. TRIPPE, and W. WEITZEN 15 Jan. 1982 65 p refs

(Contract DAAK70-81-C-0134)

(AD-A110917; GTA-A-001) Avail: NTIS HC A04/MF A01

CSCL 21D

Fire-resistant fuels have been investigated by the United States Army as a means of reducing the risk of fire in land combat vehicles and certain aircraft. One approach has been the use of high-molecular-weight polymer additives for suppression of mist formations. The polymers which are effective in mist suppression are very difficult to dissolve in fuel. A newly discovered process for dissolving high-molecular-weight polymers is investigated to determine its applicability to the preparation of mist suppression fuels. The conclusions area that certain high-molecular-weight polymers which show strong mist suppression behavior can be dissolved rapidly in diesel fuel and that the new dissolving process appears to be adaptable to field use. Author (GRA)

**N82-25616#** Los Alamos Scientific Lab., N. Mex.

### **EVALUATION OF THE SECOND HOT DRY ROCK GEOTHERMAL ENERGY RESERVOIR: RESULTS OF PHASE 1, RUN SEGMENT 5**

G. A. ZYVOLOSKI, R. L. AAMODT, R. G. AGUILAR, D. A. COUNCE, H. N. FISHER, T. A. GRANT (Zia Co., Los Alamos, N.Mex.), C. O. GRIGSBY, R. H. HENDRON, C. E. HOLLEY, JR., and R. G. LAWSON Sep. 1981 99 p refs

(Contract W-7405-ENG-36)

(DE82-002520; LA-8940-HDR) Avail: NTIS HC A05/MF A01

The results of a long term (286 day) flow test of a second hot dry rock reservoir are presented. This second reservoir was created by fracturing an interval of granitic rock located at a depth of 2.93 km (9620 ft) in the same wellbore pair used in the creation of the first, smaller reservoir. The new fracture system has a vertical extent of at least 320 m (1050 ft), suggesting that the combined heat transfer area of the old and new fracture systems is much greater than that of the old system. The virgin rock temperature at the bottom of the deeper interval was 1970 C (3860 F). Downhole measurements of the water temperature at the reservoir outlet, as well as temperatures inferred from geothermometry, showed that the thermal drawdown of the reservoir was about 80 C, and preliminary estimates indicate that the minimum effective heat transfer area of the new reservoir is 45,000 sq m (480,000 sq ft), which is six times larger than the first reservoir. DOE

**N82-25617#** Los Alamos Scientific Lab., N. Mex.

### **INVESTIGATIONS OF LOW-TEMPERATURE GEOTHERMAL POTENTIAL IN NEW YORK STATE**

D. S. HODGE, R. DERITO (State Univ. of New York, Buffalo), K. MIFIKER (State Univ. of New York, Buffalo), P. MORGAN, and C. A. SWANBERG Sep. 1981 76 p refs

(Contract W-7405-ENG-36)

(DE82-002517; LA-8960-MS) Avail: NTIS HC A05/MF A01

Temperature gradient map and published heat flow data indicate a possible potential for a geothermal resource in western and central New York State. An analysis of bottom hole temperature data for New York State confirm the existence of three positive gradient anomalies: the East Aurora, Cayuga, and Elmira anomalies, with gradients as high as 320 C/km, 360 C/km, and 360 C/km, respectively. Ground waters from two of these anomalies are enriched in silica relative to surrounding areas. Heat flows based on silica geothermometry are 50 to 70 sq mWm (+2) for the anomalies and 41.4 sq mWm (+2) for bordering regional flux. A correlation between Bouguer gravity anomalies and the temperature gradient map suggests that the geothermal anomalies may occur above radioactive granites in the basement. DOE

**N82-25620#** High Life Helicopters, Inc., Puyallup, Wash.  
**AIRBORNE GAMMA-RAY SPECTROMETER AND  
 MAGNETOMETER SURVEY, TORONTO QUADRANGLE NEW  
 YORK, VOLUME 2A Final Report**

1981 90 p refs Prepared in cooperation with QEB, Inc. 3 Vol.

(Contract DE-AC13-79GJ-01692)  
 (DE81-027158; GJBX-211-81-VOL-2A) Avail: NTIS HC A05/MF A01

No uranium anomalies meet the minimum statistical requirements as defined and no anomaly map is presented. Potassium (%K), equivalent Uranium (ppm eU), equivalent Thorium (ppm eTh), eU/eTh, eU/K, eTh/K, and magnetic pseudo-contour maps are presented. Stacked Profiles showing geologic strip maps along each flight-line, together with sensor data, and ancillary data are also presented. All maps and profiles were prepared on a scale of 1:250,000, but were reduced to 1:500,000 for presentation. DOE

**N82-25621#** High Life Helicopters, Inc., Puyallup, Wash.  
**AIRBORNE GAMMA-RAY SPECTROMETER AND  
 MAGNETOMETER SURVEY, KINGSTON QUADRANGLE NEW  
 YORK, VOLUME 2C Final Report**

1981 64 p refs Prepared in cooperation with QEB, Inc. 3 Vol.

(Contract DE-AC13-79GJ-01692)  
 (DE81-027161; GJBX-211-81-VOL-2C) Avail: NTIS HC A04/MF A01

No uranium anomalies meet the minimum statistical requirements as defined. No Uranium Anomaly Map is given. Potassium (%K), equivalent Uranium (ppm eU), equivalent Thorium (ppm eTh), eU/eTh, eU/K, eTh/K, and magnetic pseudo-contour maps are presented. Stacked Profiles showing geologic strip maps along each flight-line, together with sensor data, and ancillary data are also presented. All maps and profiles were prepared on a scale of 1:250,000, but were reduced to 1:500,000 for presentation. DOE

**N82-25622#** High Life Helicopters, Inc., Puyallup, Wash.  
**AIRBORNE GAMMA-RAY SPECTROMETER AND  
 MAGNETOMETER SURVEY, ROCHESTER QUADRANGLE NEW  
 YORK, VOLUME 2D Final Report**

1981 143 p refs Prepared in cooperation with QEB, Inc. 3 Vol.

(Contract DE-AC13-79GJ-01692)  
 (DE81-027156; GJBX-211-81-VOL-2D) Avail: NTIS HC A07/MF A01

One uranium anomaly met the minimum statistical requirements as defined. This anomaly is listed and is shown on the Uranium Anomaly Interpretation Map. Potassium (%K), equivalent Uranium (ppm eU), equivalent Thorium (ppm eTh), eU/eTh, eU/K, eTh/K, and magnetic pseudo-contour maps are also presented. Stacked Profiles showing geologic strip maps along each flight-line, together with sensor data, and ancillary data are presented. All maps and profiles were prepared on a scale of 1:250,000, but were reduced to 1:500,000 for presentation. Anomaly number 1 is over an area underlain by shale and dolomite of the upper Silurian Camillus and Syracuse formations (Scy). DOE

**N82-25624#** Los Alamos Scientific Lab., N. Mex.  
**METHANE HYDRATE RESOURCE ASSESSMENT PROGRAM  
 Progress Report, Jul. - Sep. 1980**

B. L. BARRACLOUGH, P. L. MCGUIRE, and S. P. KOCZAN Sep. 1981 36 p refs

(Contract W-7405-ENG-36)  
 (DE82-002478; LA-8933-PR; QR-2) Avail: NTIS HC A03/MF A01

Progress on a program to study the nature, occurrence, and resource potential of methane (natural gas) hydrate is described. Planning for an experimental field program is continuing and a range of feasible field efforts is outlined. A variety of methods and equipment suitable for hydrate coring work was identified. A new cryogenic wireline coring system, which is intended for use

with very cold drilling fluids, was developed for retrieving hydrated samples from subsurface strata, and details are presented. A unique concept for forming hydrate in the pore space of various sediments is outlined, and details of the proposed experimental apparatus are given. Continuing studies of hydrate gas production by thermal stimulation methods indicate that steam injection is not practical. Two reservoir computer models were developed, which are believed to bracket probably hydrate gas production rates. These models are discussed and the preliminary results of reservoir parameter studies are presented. DOE

**N82-25627#** Geological Survey, Helena, Mont.  
**MEAN ANNUAL STREAMFLOW OF SELECTED DRAINAGE  
 BASINS IN THE COAL AREA OF SOUTHEASTERN MONTANA  
 Final Water Resources Investigations**

R. F. FERREIRA Oct. 1981 28 p refs Prepared in cooperation with EPA

(PB82-137696; USGS/WRD/WRI-81/097; USGS/WRI-81-61)  
 Avail: NTIS HC A03/MF A01 CSCL 08H

Streamflow characteristics of drainage basins within the Fort Union coal region of southeastern Montana were estimated to provide premining data for evaluating the future effects of mining on the environment. Estimated annual mean streamflow at 22 data collection stations ranged from 0 to 887 cubic feet per second. These estimates are based on miscellaneous streamflow records at each station and continuous streamflow records from other stations in the study area. Estimated mean annual streamflow for a 10 year period ranged from 0 to 572 cubic feet per second. Many of the drainage basins had a mean annual runoff of less than 0.60 inch; the maximum observed mean annual runoff was 4.45 inches. GRA

**N82-25635\*#** Detroit Diesel Allison, Indianapolis, Ind.  
**LOW NOX HEAVY FUEL COMBUSTOR CONCEPT PROGRAM  
 Final Report**

A. S. NOVICK and D. L. TROTH Oct. 1981 206 p refs  
 (Contract DEN3-148; DE-AI01-77ET-13111)

(NASA-CR-165367; NAS 1.26:165367; DDA-EDR-10594;  
 DOE/NASA/0148-1) Avail: NTIS HC A10/MF A01 CSCL 10B

The development of the technology required to operate an industrial gas turbine combustion system on minimally processed, heavy petroleum or residual fuels having high levels of fuel-bound nitrogen (FBN) while producing acceptable levels of exhaust emissions is discussed. Three combustor concepts were designed and fabricated. Three fuels were supplied for the combustor test demonstrations: a typical middle distillate fuel, a heavy residual fuel, and a synthetic coal-derived fuel. The primary concept was an air staged, variable-geometry combustor designed to produce low emissions from fuels having high levels of FBN. This combustor used a long residence time, fuel-rich primary combustion zone followed by a quick-quench air mixer to rapidly dilute the fuel rich products for the fuel-lean final burnout of the fuel. This combustor, called the rich quench lean (RQL) combustor, was extensively tested using each fuel over the entire power range of the model 570 K engine. Also, a series of parametric tests was conducted to determine the combustor's sensitivity to rich-zone equivalence ratio, lean-zone equivalence ratio, rich-zone residence time, and overall system pressure drop. Minimum nitrogen oxide emissions were measured at 50 to 55 ppmv at maximum continuous power for all three fuels. Smoke was less than a 10 SAE smoke number. M.G.

**N82-25726#** Los Alamos Scientific Lab., N. Mex.  
**EXPLOSIVELY PRODUCED FRACTURE OF OIL SHALE  
 Progress Report, Jul. - Sep. 1980**

Oct. 1981 38 p

(Contract W-7405-ENG-36)  
 (DE82-004182; LA-9045-PR) Avail: NTIS HC A03/MF A01

Explosive cratering experiments were conducted as a part of the research effort to study the explosively produced fracture of oil shale. They were designed to identify and analyze the major factors involved in the fracturing of oil shale, to provide data for the verification of the computer models, and ultimately to lead to

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the design of a rubble bed for in situ retorting oil shale. The rubble excavated from eight cratering experiments was separated and the volumes of rubble in each screened size category are presented. Also presented are the data from the detailed investigation of the joint/fracture attitudes (strikes and dips) within a crater interior after excavation. The data were tabulated and plotted to allow future comparisons and analyses pertinent to similar experiments. A brief discussion of the experiment site and the graphical representation of the data are included. Finally, since the homogeneity of the oil shale is an important consideration in the selection of a site for these explosive fracture experiments, cores were taken and analyzed. The identification of the geological parameters and their extent and how they delineate the overall characterization of the experiment site, including the subsurface geology, is given. It is shown how the postshot core analysis will indicate how the blast affected the rock. M.D.K.

**N82-25731#** Geological Survey, Reston, Va.  
**A SUMMARY OF ENVIRONMENTAL GEOLOGIC STUDIES ON THE SOUTHEASTERN UNITED STATES ATLANTIC OUTER CONTINENTAL SHELF Final Open File Report, 1977 - 1978**  
P. POPENOE 1981 48 p refs  
(PB82-109273; BLM/YL/SR-81/03) Avail: NTIS HC A03/MF A01 CSCL 08G

The outer continental shelf environment is investigated. The methods, techniques, instruments, and procedures utilized in acquiring sound management decisions regarding the development of mineral resources are summarized. GRA

**N82-25780#** California Univ., Irvine, Dayton, Ohio.  
**TOXIC HAZARDS RESEARCH UNIT Annual Technical Report, Jun. 1980 - May 1981**  
J. D. MACEWEN and E. H. VERNOT Wright-Patterson AFB, Ohio AMRL Dec. 1981 139 p refs  
(Contract F33615-80-C-0512; AF PROJ. 6302; MF58524025) (AD-A110587; AFAMRL-TR-81-126) Avail: NTIS HC A07/MF A01 CSCL 06T

Chronic toxicity or oncogenic studies were carried out with methylcyclohexane, purified 1,1-dimethylhydrazine, Otto Fuel II, JP-10, RJ-5, and JP-4. A subchronic inhalation study was conducted with shale derived JP-5 and Decalin fuels. Acute toxicity studies were conducted on a variety of chemical agents used by the Air Force and Navy. GRA

**N82-25944#** Los Alamos Scientific Lab., N. Mex.  
**SPACE NUCLEAR SAFETY AND FUELS PROGRAM Progress Report, May 1981**  
S. E. BRONISZ, comp. Oct. 1981 26 p refs  
(Contract W-7405-ENG-36) (DE82-004183; LA-9042-PR) Avail: NTIS HC A03/MF A01

The use of Plutonium 238 in radioisotopic power systems is discussed. A 250 W modular heat source fueled with Plutonium 238 was subjected to impact tests. All six fuel pellets cracked. The welding and weld inspection of the fuel pellet capsules is described. In preparation for overpressure tests of a lightweight radioisotope heater unit, attempts were made to experimentally reach launch pad pressures of 2000 psi. Eight helium release experiments using fragments of fuel pellets were completed. DOE

**N82-25945#** Los Alamos Scientific Lab., N. Mex.  
**SPACE NUCLEAR SAFETY AND FUELS PROGRAM Progress Report, Jun. 1981**  
S. E. BRONISZ, comp. Oct. 1981 16 p refs  
(Contract W-7405-ENG-36) (DE82-004188; LA-9076-PR) Avail: NTIS HC A02/MF A01

Studies related to the use of Plutonium 238 in radioisotope power systems are presented. Most of the studies discussed are ongoing. A lightweight radioisotope heater unit was tested. Nine calibration tests were completed to prepare for overpressure tests of the unit. A 250 W modular heat source fueled with Plutonium 238 was tested. Its iridium clads were subjected to impact tests.

All four clads were cracked on impact. The microstructure of the welds were examined. DOE

**N82-26053#** Los Alamos Scientific Lab., N. Mex.  
**ANALYSIS OF ALTERNATE-FUELED PASSENGER VEHICLES: A SAMPLE TECHNOLOGY ASSESSMENT**  
A. T. PEASLEE, JR. and G. R. THAYER Oct. 1981 18 p refs  
(Contract W-7405-ENG-36) (DE82-004190; LA-9068-MS) Avail: NTIS HC A02/MF A01

Ten passenger vehicles powered by the following were characterized on a common engineering and economic basis: gasoline internal combustion, diesel internal combustion, liquid-hydrogen internal combustion, liquid-hydrogen fuel cell, hydrogen internal combustion, hydrogen fuel cell, methanol internal combustion, methanol fuel cell, Ni/Zn battery, and Pb/Acid battery. Levelized life cycle costs were computed for each vehicle. The market penetration of the nongasoline vehicles was studied over a 50 yr period using a generalized equilibrium energy economic model. Results indicate that only the methanol internal combustion vehicle using methanol produced from coal is a viable alternative to the gasoline internal combustion vehicle. The market penetration of alternate vehicles was enhanced more by reduction in acquisition costs than by comparable improvements in engineering parameters. DOE

**N82-26303#** Naval Postgraduate School, Monterey, Calif. Dept. of Aeronautics.  
**COMBUSTION BEHAVIOR OF SOLID FUEL RAMJETS. VOLUME 2: EFFECTS OF FUEL PROPERTIES AND FUEL-AIR MIXING ON COMBUSTION EFFICIENCY Final Report**  
Aug. 1981 54 p refs  
(AD-A110796; NPS67-81-011) Avail: NTIS HC A04/MF A01 CSCL 21E

Fundamental SFRJ fuel properties were determined using a DTA and a gas chromatograph for both high and low heating rates. The performance of these fuels was then measured under various operating conditions and test geometries. Fuel-properties were found to have some effect on the obtainable combustion efficiency but much larger effects could be induced by the flow conditions (induced mixing near the fuel surface, bypass air, etc.). Author (GRA)

**N82-26312#** Monsanto Research Corp., Dayton, Ohio.  
**TURBINE ENGINE LUBRICANT RECLAMATION Interim Report, 1 Sep. 1979 - 1 Feb. 1981**  
G. L. BEEMSTERBOER and R. J. BRUNS Wright-Patterson AFB, Ohio AFWAL Dec. 1981 132 p refs HC A06/MF A01  
(Contract F33615-79-C-2052; AF PROJ. 3048) (AD-A112098; MRC-DA-1057; AFWAL-TR-81-2053) Avail: NTIS HC A06/MF A01 CSCL 11H

A distillation and adsorption treatment for reclaiming used MIL-L-7808 turbine oils was investigated. A viable additive package was tested on different MIL-L-7808 type virgin base stocks. Fifteen used oils were analyzed by acid number, high performance liquid chromatography, and gas chromatography. A distillation process utilizing caustic (sodium hydroxide) pretreatment was developed on 500-ml and 13-litre scales. Adsorption treatment of distilled oils with calcium hydroxide followed by attapulgus clay was examined. Preparations for large-scale (25 and 250 gal) reclamations are currently under way to elucidate the validity of caustic distillation and absorbent treatment parameters. Author (GRA)

**N82-26422#** Massachusetts Inst. of Tech., Cambridge. Dept. of Chemical Engineering.

**CROSSED-REACTION NETWORKS IN THE CATALYTIC HYDRODENITROGENATION OF SYNTHETIC LIQUID FUELS**

**Quarterly Report, 1 Aug. - 31 Oct. 1981**

C. N. SCATTERFIELD and S. HSI 1981 8 p

(Contract DE-AC22-80PC-30075)

(DE82-003092; DOE/PC-30075/7) Avail: NTIS HC A02/MF

A01

The effect of the ratio of hydrogen sulfide to quinoline on the HDN reaction was explored. Increasing the CS<sub>2</sub>/quinoline mole ratio to 2 caused a drop in total HDN activity from the maximum plateau level observed at a ratio of about 0.5. Throughout, an increase in this ratio causes a continuous enhancement of the hydrogenolysis reactions and inhibition of hydrogenation reactions in the reaction network. A large amount of kinetic data was taken using quinoline, BzTHQ (5,6,7,8-tetrahydroquinoline) and orthopropylaniline as a feed with various partial pressures of hydrogen sulfide present. The computer modelling of these kinetic data is still underway. The catalytic activity for HDN reaction increased with increased partial pressure of hydrogen sulfide during the initial sulfiding and resulfiding procedures. DOE

**N82-26425#** Gulf Research and Development Co., Pittsburgh, Pa.

**FUNDAMENTALS OF COAL DEPOLYMERIZATION: KINETIC MODELING AND EXPERIMENTAL DETERMINATION OF FREE RADICAL CHEMISTRY AND MINERAL MATTER EFFECTS IN DIRECT COAL HYDROLIQUEFACTION**

**Quarterly Report, 1 Jul. - 30 Sep. 1981**

L. PETRAKIS, G. L. JONES, and D. W. GRANDY Sep. 1981 236 p refs

(Contract DE-AC01-79ET-14940)

(DE82-003689; DOE/ET-14940/6) Avail: NTIS HC A11/MF A01

Fundamental phenomena involved in coal depolymerization under hydroliquefaction conditions were investigated. The role of free radical formation and behavior on the degree of coal dissolution and the quality of the product are discussed. Electron spin resonance measurements of coal dissolution as it is affected by mineral matter were performed. Solids isolated from hydroliquefaction experiments were added to determine the effect of added mineral matter on free radical formation. The degree of liquefaction and the quality of product obtained were assessed. Standard separation techniques were used to obtain overall conversion fractions and solubility-defined fractions such as oils, preasphaltenes, and asphaltenes. The conversion data and the free radical formation are used to develop a kinetic/mechanistic model. DOE

**N82-26426#** Pittsburgh Univ., Dept. of Chemical and Petroleum Engineering.

**SUPERCRITICAL FLUIDS FOR REACTION AND EXTRACTION OF COAL AND HEAVY OILS**

**Quarterly Progress Report, 1 Sep. - 30 Nov. 1981**

G. D. HOLDER, J. GOPAL, and G. V. DESHPANDE Dec. 1981 8 p

(Contract DE-FG22-81PC-40800)

(DE82-005496; DOE/PC-40800/1; QPR-1) Avail: NTIS HC A02/MF A01

A program for the study of supercritical extraction of coal and coal liquids is discussed. A fundamental understanding of supercritical extraction with emphasis on extraction of coal liquids with supercritical water and deashing of coal liquids, solvent refined coal - bottoms and possibly shale oils is sought. The use of supercritical extraction techniques for extraction and fractionation of heavy residues which are often mixed with mineral matter and other non-volatile matter is discussed. The supercritical extraction of model compounds and their mixtures is discussed. An experimental apparatus and procedure were designed and ordered. A schematic diagram of the experimental set-up is shown. A special custom-made autoclave reactor was designed. The reactor is a 1 liter MagneDrive 2 agitated autoclave rated at 500 psi and 450 C and provided with ports for inlet and outlet for the process

components, temperature and pressure measurement and cooling water connections. The reactor will be provided with a multiple zone electric furnace for heating the reactor to operating conditions. The top of the reactor (flange), and sampling tubes will be provided with heating elements so as to maintain a constant temperature throughout the reactor and sampling line assembly. DOE

**N82-26427#** SRI International Corp., Menlo Park, Calif. Materials Research Lab.

**MECHANISM OF CATALYTIC GASIFICATION OF COAL CHAR**

**Quarterly Technical Progress Report, 1 Jan. - 31 Mar. 1981**

B. J. WOOD, K. M. SANCER, K. H. LAU, D. R. SHERIDAN, and H. WISE 15 Apr. 1981 56 p refs

(Contract DE-AC21-80MC-14593; SRI PROJ. 2202)

(DE82-004074; DOE/MC-14593/T1; QTPR-2) Avail: NTIS HC A04/MF A01

The mechanisms involved in the catalytic gasification reactions of coal char, from Illinois No. 6 coal, were studied and specific reaction steps and parameters that control the catalytic process were identified. To determine catalytic pathways and intermediate species, two experimental techniques were used. Temperature programmed reaction reveals the rate of formation of stable gaseous products and Knudsen cell mass spectrometry reveals the partial pressures of vapor species in equilibrium with the solid char. Physical measurements of the char including structural analysis (scanning electron microscopy), determination of internal surface area of char samples, (BET N<sub>2</sub>-isotherms) and evaluation of free-radical densities in char and carbons exposed to various pretreatments (electron spin resonance) were performed. Results suggest the operation of a redox couple (involving the catalyst cation) as a significant mechanistic step in the catalytic gasification of coal char. DOE

**N82-26429#** Battelle Columbus Labs., Ohio.

**NOVEL APPROACH TO COAL GASIFICATION USING CHEMICALLY INCORPORATED CATALYSTS, PHASE 2 Final Report, May 1978 - Jun. 1981**

H. F. FELDMANN, H. N. CONKLE, H. R. APPELBAUM, and S. P. CHAUHAN 1981 138 p refs

(Contract W-7405-ENG-92)

(DE82-003869; BMI-2088) Avail: NTIS HC A07/MF A01

A catalytic coal gasification system involving thorough incorporation of CaO catalyst into the coal is described. The catalytic treatment system can be used to improve both existing commercial gasification processes as well as advanced gasification systems. One gasification system that appears exceptionally attractive utilizing the treatment system is direct fluid bed hydrogasification or hydrolysis. A simple pressurized fluid bed steam/oxygen gasification system is also an attractive option which could be commercialized quickly. The technical and economic advantages of these approaches are demonstrated. DOE

**N82-26430#** Battelle Columbus Labs., Ohio.

**NOVEL APPROACH TO COAL GASIFICATION USING CHEMICALLY INCORPORATED CATALYSTS, PHASE 2. APPENDIX A-F Final Report, May 1978 - Jun. 1981**

H. F. FELDMANN, H. N. CONKLE, H. R. APPELBAUM, and S. P. CHAUHAN 1981 164 p refs

(Contract W-7405-ENG-92)

(DE82-003804; BMI-2088-APP-A-F) Avail: NTIS HC A08/MF A01

Data generated in investigations of a catalytic coal gasification system involving thorough incorporation of CaO catalyst into the coal are presented. Included are descriptions of the experimental apparatus, test conditions, and results of catalytic coal treatment; direct hydrogasification data; summaries of test runs for hydrogasification of BTC, hydrogasification of char, and steam/O<sub>2</sub> gasification; and process analysis information. Forty tables and nine figures are also included. DOE

## 04 FUELS AND OTHER SOURCES OF ENERGY

**N82-26481\*#** National Aeronautics and Space Administration. Pasadena Office, Calif.

### **SUPERCRITICAL SOLVENT COAL EXTRACTION Patent Application**

L. E. COMPTON, inventor (to NASA) (JPL, California Inst. of Tech., Pasadena) 17 Nov. 1981 18 p

(Contract NAS7-100)

(NASA-CASE-NPO-15210-1; US-PATENT-APPL-SN-322312)

Avail: NTIS HC A02/MF A01 CSCL 21D

Yields of soluble organic extract are increased up to about 50% by the supercritical extraction of particulate coal at a temperature below the polymerization temperature for coal extract fragments (450 C) and a pressure from 500 psig to 5,000 psig by the conjoint use of a solvent mixture containing a low volatility, high critical temperature coal dissolution catalyst such as phenanthrene and a high volatility, low critical temperature solvent such as toluene.

NASA

**N82-26484#** Air Force Wright Aeronautical Labs., Wright-Patterson AFB, Ohio. Fuels Branch.

### **JET FUEL FROM SHALE OIL: THE 1981 TECHNOLOGY REVIEW**

H. R. LANDER, JR. Dec. 1981 257 p refs Proceedings of Symp., Miamisburg, Ohio, 17-18 Nov. 1981

(Contract AF PROJ. 3048)

(AD-A111217; AFWAL-TR-81-2135) Avail: NTIS HC A12/MF

A01 CSCL 21D

The 'Jet Fuel From Shale Oil - 1981 Technology Review' culminated three years of Air Force Shale Oil related programs. Final economic optimized results of three processing studies evaluating the yield, cost and quality of JP-4 and JP-8 jet fuel produced from whole crude shale oil are discussed. Reported also are technologies associated with a newly developed nitrogen tolerant catalyst and conclusions of combustion studies performed on shale derived JP-4 jet fuel samples and Nuclear Magnetic Resonance (NMR) analyses of the composition of shale derived jet fuel samples.

Author (GRA)

**N82-26485#** Center for Naval Analyses, Alexandria, Va. Naval Studies Group.

### **MOBILITY FUELS FOR THE NAVY**

T. ONEILL Jan. 1982 21 p refs

(Contract N00014-76-C-0001)

(AD-A112511; CNA-PP-336) Avail: NTIS HC A02/MF A01

CSCL 21D

As fuel declines, both specifications and engine designs will have to be modified to accommodate this change. In addition, specifications have to reflect the fact that fuel chemistry itself is undergoing change, so that new problems have begun to arise. Recently, batches of DFM and JP-5 that passed inspection have been associated with fuel filter clogging and excessive smoking. The mechanisms of these effects are not clearly understood. As synfuels are introduced, the variety of chemicals in fuels will be greatly expanded, and this will cause a new range of problems. Besides modifying the specifications of current fuels to address the issues of price and availability, other ways might come from changing the types of fuel burned. The Navy could attempt to switch to fuels in civilian use. Number 2 diesel oil is similar to the ship fuel DFM, while Jet A-1 is not unlike the aircraft fuel JP-5. Another approach could involve the use of just one type of fuel for both ships and airplanes. This would reduce storage and handling costs, perhaps enough to offset the modest differential of 5 cents per gallon between JP-5 and DFM that existed in October 1981.

GRA

**N82-26486#** Southwest Research Inst., San Antonio, Tex. Army Fuels and Lubricants Research Lab.

### **IMPACT OF GASOHOL ON THE L-141 AND LDT-465-1C ENGINES Interim Report, Oct. 1980 - Sep. 1981**

W. E. LIKOS and D. M. YOST Dec. 1981 110 p refs

(Contract DAAK70-80-C-0001; DAAK70-82-C-0001; DA PROJ.

1L2-63104-D-150)

(AD-A112010; AFLRL-148) Avail: NTIS HC A06/MF A01

CSCL 21D

Gasohol was analyzed in the L-141 and LDT-465-1C engines in order to determine its impact upon engine operability. During various steady-state operating conditions, with the L-141 engine, gasohol was found to improve economy under heavily loaded conditions, while a deterioration will occur during light and intermediate loading. An evaluation of emission and nonemission-regulated carburetors shows the nonemissions carburetor better suited for gasohol use. No effects on maximum power produced were noted with gasohol. Simulated driveability tests with the L-141 engine on a dynamometer showed differences in engine response between the different fuels, but actual vehicle tests proved that driveability was not altered. A relatively short endurance test with the L-141 engine on gasohol fuel indicates, based on engine oil analysis, no significant change in engine wear rates. The endurance test did indicate, however, that more frequent oil drain intervals may be required due to TBN depletion of the engine oil. Cold start testing of the LDT-465-1C engine indicates that gasohol is of inadequate cetane number to sustain normal engine operation. Thus, it is recommended that gasohol not be used in the LDT-465 family of engines.

Author (GRA)

**N82-26487#** Southwest Research Inst., San Antonio, Tex. Army Fuels and Lubricants Research Lab.

### **DEVELOPMENT OF ARMY HIGH-ENERGY FUEL DIESEL/TURBINE-POWERED SURFACE EQUIPMENT, PHASE 2 Interim Report, Oct. 1979 - Sep. 1981**

W. W. WIMER and D. M. YOST Dec. 1981 134 p refs

(Contract DAAK70-80-C-0001; DAAK70-82-C-0001; DA PROJ.

1L7-62733-AH-20)

(AD-A111942; AFLRL-147) Avail: NTIS HC A07/MF A01

CSCL 21D

The Army is interested in those fuels that have a high-energy content per unit volume and therefore result in increased payload capabilities and/or extended operational range of the vehicle. A series of screening processes are being used to identify those fuels and/or fuel components that could result in an increase of 10 percent in the range of the vehicle without an increase in the fuel tank size, i.e., fuels with a high-energy content percent volume. The chemical and physical properties of various candidate fuels and fuel components are described. The fuel components included both liquids and solids (at room temperature). The blending of the various components and the characterization of the resulting fuels are outlined. Solubility studies were done on some of the solid components to assist in obtaining the resulting fuel in the more desirable liquid state. Those solid components, such as anthracene, that were insoluble in the tests conducted but judged to have good high-energy potential, were studied as slurries. Catalyzed 'carbon black' was investigated. Settling studies with carbonaceous fuels included the effect of temperature upon the stability, the stability of FRF-carbon slurries, and the refinement of the previously reported 'Freezing Tube Technique' for measuring stability. Impact dispersion tests were conducted to study the fire-safety characteristics of energy-augmented fuels. The screening of candidate fuels with the Petter engine is described in detail. Other engine studies with the CLR engine are also included.

Author (GRA)

**N82-26488#** Southwest Research Inst., San Antonio, Tex. Army Fuels and Lubricants Research Lab.

**REVIEW OF PHYSICAL AND CHEMICAL METHODS FOR CHARACTERIZATION OF FUELS Interim Report, Mar. 1980 - Dec. 1981**

R. G. ZOSCHAK and L. L. STAVINOHA Dec. 1981 246 p refs

(Contract DAAK70-80-C-0001; DAAK70-82-C-0001; DA PROJ. 1L7-62733-AH-20)

(AD-A111943; AFLRL-151) Avail: NTIS HC A11/MF A01 CSCL 21D

This report provides a tabulation of chemical compounds and physical/chemical properties with methods for their determination based on a review of physical and chemical methods for characterizing liquid mobility fuels. This tabulation is cross-referenced to a list of references organized by preselected categories. A complete bibliography is provided alphabetically by author's last name, both with and without annotations. For ease in utilization and updating, a system was developed to facilitate tabulation and recall of references from a word processor in which they are stored. While this tabulation serves as reference material to a program to develop improved analytical and correlative methodology for characterizing fuels, it may be of great utility to personnel developing and analyzing fuels. This tabulation will continue to be expanded and updated periodically.

Author (GRA)

**N82-26492#** Texas Univ., Austin. Center for Energy Studies.  
**SYNTHETIC-FUEL PRODUCTION USING TEXAS LIGNITE AND A VERY HIGH TEMPERATURE GAS COOLED REACTOR FOR PROCESS HEAT AND ELECTRICAL POWER GENERATION**

M. A. ROSS and D. E. KLEIN May 1981 90 p refs  
(DE82-900466; UT/CES-RR-13) Avail: NTIS HC A05/MF A01

Two alternatives to increased reliance on foreign energy sources are presented which utilize the abundant domestic resources of coal, uranium, and thorium. The gasification and liquefaction of coal are accomplished with Lurgi gasifiers and Fischer-Tropsch synthesis. A 50,000 barrel per day facility, consuming 15 million tons of lignite coal per year, is used. A nuclear assisted coal conversion approach using a very high temperature gas cooled reactor with a modified Lurgi gasifier and Fischer-Tropsch synthesis is also described.

DOE

**N82-26493#** California Univ., Livermore. Lawrence Livermore Lab.

**LLNL UNDERGROUND COAL-GASIFICATION PROJECT Quarterly Progress Report, Apr. - Jun. 1981**

D. U. OLNESS, ed. and W. CLEMENTS, ed. 27 Jul. 1981 41 p refs

(Contract W-7405-ENG-48)

(DE82-002074; UCRL-50026-81-2) Avail: NTIS HC A03/MF A01

Laboratory studies of forward gasification in small blocks of coal, approximately 12 inches on a side are discussed. The coal is ignited near the inlet to a small hole drill through the center of the block, and a steam/oxygen mixture is fed through the hole to support the combustion. The ability to visually inspect the gasification cavities formed in these laboratory-scale experiments enhances understanding of the in situ gasification process. At the end of each experiment the coal block is split open and the cavity is examined. It was found that for the three coals studied for far (two from Wyoming and one from Washington) the cavities appear quite different, yet the product-gas heating values are very similar. A mathematical model for the small coal block experiments is under development in order to improve understanding of the physical and chemical processes governing the burning of the coal and the growth of the cavity within the block. Combined chemical kinetic and mass transfer rates were developed for the model. Results with the model were compared against experimentally observed cavity shapes burned in coal.

DOE

**N82-26495#** Illinois Univ., Urbana. Dept. of Agricultural Engineering.

**ALCOHOL DISTILLATION BY INTERNAL-COMBUSTION ENGINES Final Report**

D. HUNT 20 Nov. 1981 6 p

(Contract DE-AC02-81AF-92002)

(DE82-005294; DOE/AF-92002/1) Avail: NTIS HC A02/MF A01

An internal combustion engine was fitted with an apparatus to enable waste heat capture for the distillation of fermented corn beer into 180-proof ethanol engine fuel. A performance test was conducted in the continuous mode of operation.

DOE

**N82-26496#** Arizona State Univ., Tempe. Coll. of Engineering and Applied Sciences.

**CONVERSION OF CELLULOSIC WASTES TO LIQUID FUELS Interim Report**

J. L. KUESTER Sep. 1981 77 p refs

(Contract DE-AS02-76CS-40202)

(DE82-001173; DOE/CS-40202/T5; COO-2982-74) Avail: NTIS HC A05/MF A01

The history, current status, and future plans for a project to convert waste cellulosic (biomass) materials to liquid hydrocarbon fuels are described. The process utilizes an indirect liquefaction approach (gasification followed by liquefaction) to produce a quality liquid hydrocarbon product similar to diesel fuel. A variety of feedstocks can be processed with product quality essentially independent of feedstock type. Operation of the system in an integrated, continuous mode and direct measurement and assessment of product yields are described. Additional factor studies (gasification, fluidizing gas type, solid type, and operating conditions) were also performed.

DOE

**N82-26497#** Energy and Minerals Research Co., Exton, Pa.

**APPLICATION OF ULTRASONIC TECHNIQUES TO CHEMICAL COAL CLEANING PROCESSES Final Report, 15 Apr. 1980 - 15 Aug. 1981**

W. B. TARPLEY, JR., E. N. TWESME, P. L. HOWARD, and G. R. MOULDER Aug. 1981 52 p refs

(Contract DE-AC22-80PC-30143)

(DE82-003093; DOE/PC-30143/T4) Avail: NTIS HC A04/MF A01

Ultrasonic activation was applied to several coal cleaning processes, including chlorinolysis, oxydesulfurization, and sodium hypochlorite leaching, in small-scale batch treatment processing of Illinois No. 6, Lower Kittanning, and Western Kentucky No. 11 coals. In all cases, ultrasonic energy application demonstrated effects that would translate in production to processing efficiencies and/or capital equipment savings. Specifically, in the chlorinolysis reaction, pyritic sulfur was removed 23 times faster with ultrasonics than without it. (Organic sulfur could not be removed from the coal examined with or without ultrasonics in the chlorinolysis process). In sodium hypochlorite leaching, the total sulfur extraction rate was 3 times faster with ultrasonics. Two separate benefits were seen with oxydesulfurization: ultrasonics doubled the reaction rate and at slightly accelerated rates allowed a pressure reduction from 960 to 500 psi, which would be a significant cost efficiency in production.

DOE

**N82-26498#** Rockwell International Corp., Canoga Park, Calif. Energy Systems Group.

**MOLTEN SALT COAL GASIFICATION PROCESS DEVELOPMENT UNIT, PHASE 2 Quarterly Progress Report, Apr. - Jun. 1981**

M. H. SLATER 21 Jul. 1981 57 p

(Contract DE-AC21-77ET-10296)

(DE82-004717; DOE/ET-10296/194; QTPR-4) Avail: NTIS HC A04/MF A01

A molten salt coal gasification process development unit (PDU) program is discussed. A one-year operations program utilizing the existing PDU was planned to include a series of runs, each additional run progressively utilizing more plant hardware and subsystems and operating under increasingly severe conditions.

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Run 7 data were evaluated and reported continuously on schedule for a full 7 days; the melt overflow system operated smoothly throughout the entire gasification program; a coal throughput of approximately 1 TPH, the rated design capacity of system, was achieved; the gasifier/quench system operated satisfactorily at a planned 15% ash in the melt; and the gasification system operated as predicted at 10-atm pressure over extended periods and satisfactorily at pressures up to 18 atm. The ash removal, sulfur removal, and sodium carbonate regeneration systems were all placed on line during the run. During Run 9 Illinois No. 6 coal was gasified at 20 atm pressure and at coal throughput of nominal 1 TPH and the gasifier was operated with the ash content in the melt at the design 20% concentration. The post-test inspection after PDU Run 9 is continued. Data reduction, data evaluation, and performance analysis of the various components and subsystems in the balance of plant are in progress. DOE

**N82-26499#** Westinghouse Electric Corp., Madison, Pa. Synthetic Fuels Div.

### **ADVANCED COAL GASIFICATION SYSTEM FOR ELECTRIC POWER GENERATION Quarterly Progress Report, 1 Jan. - 31 Mar. 1981**

22 Apr. 1981 53 p

(Contract DE-AC21-80ET-14752)

(DE82-004539; DOE/ET-14752/16; QPR-2) Avail: NTIS HC A04/MF A01

Major activity was directed toward maintenance and modification of the process development of a pressurized fluidized bed gasification system. Currently, final assembly and preparation are in progress for tests to be conducted. The last part of commissioning test TP-M001-4, which is a functional checkout of the model structure and associated subsystems, was completed. From the experiments performed in a bed of wide size particle distribution, the two dimensional, wedge-shaped pitot tube with continuous gas purge successfully prevented the plugging of the tube holes over a long period of operation and simultaneously provided the required sensitivity of measurement. The pitot tube was calibrated in the wind tunnel at 0, 250, 310, and 390 cm(3)/m purge flow. These results will provide guidance for the operation of the purged pitot tube in the cold flow scaled-up facility. A simple mathematical model was proposed to estimate the solids circulation rate induced by a bubbling jet. Certain parameters in the model will require verification from cold flow experiments designed for this purpose. Two series of experiments were completed to investigate the motion of solid particles in the gasifier. The rate of particle mixing was studied as a function of the jet injection velocity. DOE

**N82-26501#** Utah Univ., Salt Lake City. Dept. of Mining and Fuels Engineering.

### **CONCEPTS OF FUNDAMENTAL PROCESSES RELATED TO GASIFICATION OF COAL Quarterly Progress Report, Oct. - Dec. 1980**

W. H. WISER May 1981 6 p

(Contract DE-AM03-77SF-01484)

(DE81-023067; DOE/SF-01484/T1; FE-1484-5) Avail: NTIS HC A02/MF A01

Single stage catalytic coal gasification, single stage coal gasification to high Btu gas, and reactions of aromatic compounds with steam are discussed. The objective of the first project is to optimize the process variables and catalyst systems to maximize methane yields. The objective of the second investigation is to investigate the potential for obtaining high methane yields by direct catalytic hydrogenation of coal in a single stage with a maximum temperature of 550 C. The objectives for project three are: to

develop a catalyst of suitable activity and sufficient life; to determine the conversion and approach to equilibrium as a function of the main variables of the reaction (temperature, pressure, contact time and steam/carbon ratio); and to determine reaction mechanisms and kinetics of the reforming reactions. Various construction activities are reported. DOE

**N82-26502#** Utah Univ., Salt Lake City. Dept. of Mining and Fuels Engineering.

### **CONCEPTS OF FUNDAMENTAL PROCESSES RELATED TO GASIFICATION OF COAL Quarterly Progress Report, Apr. - Jun. 1981**

W. H. WISER Sep. 1981 8 p

(Contract DE-AM03-77SP-01484)

(DE82-000764; DOE/SF-01484/T3; FE-1484-7) Avail: NTIS HC A02/MF A01

Single stage catalytic coal gasification and the reaction of aromatic compounds with steam are discussed. The primary objective of the coal gasification is to optimize the process variables and catalyst systems to maximize methane yields. During this quarter, the gasification system was set up and pressure tested. The electrical system was also completed and is functional. The thermocouples and slurry feed system are being installed. The purpose of the steam process study is to assess the feasibility of coal liquefaction-steam reforming of coal-derived liquids for the production of synthesis gas and hydrogen. To date, a reactor has been built which is composed of two zones: the preheat and reaction zone and the control and product analysis zone. The Packard 7400 series gas chromatography system was redesigned. A thermal conductivity detector for H<sub>2</sub>, CO and CO<sub>2</sub> analysis and flame ionization detector for hydrocarbon analysis can be used at the same time. The flow rates (water and benzene) and percent stroke (controlled volume pump) were established. Preliminary experiments were attempted with steam benzene mixtures at atmospheric pressure to establish the operating and analytical procedure. DOE

**N82-26692#** General Electric Co., Schenectady, N. Y. Gas Turbine Div.

### **HIGH-TEMPERATURE TURBINE TECHNOLOGY PROGRAM ROTOR WATER DELIVERY AND DISTRIBUTION TESTS**

M. W. HORNER Sep. 1981 107 p refs

(Contract DE-AC01-76ET-10340; EX-76-C-01-1806)

(DE82-000400; DOE/ET-10340/120) Avail: NTIS HC A06/MF A01

The design, fabrication, and test of a rotor water delivery and distribution system for an integrated gasification combined cycle power plant typical of the technology readiness vehicle (TRV) high temperature turbine (HTT) design conditions are described. The delivery and distribution of bucket cooling water were evaluated. This included water transfer onto the rotor, water metering to individual buckets, and water distribution among the cooling passages within each bucket. This task was accomplished by conducting rotating tests at the TRV gravitational force level and a wide range of water flow rates to demonstrate the following technology: transfer of water from a stationary supply onto the turbine rotor using a water commutator; delivery of water through the rotor to a circumferential manifold and its uniform metering to the individual buckets via individual orifices (one orifice to feed one bucket); uniform distribution of water to the cooling passages of each bucket via a resistance flow divider (RFD) at the bucket dovetail; and verification of turbine rotor dynamic stability with varying water flows and rotor speeds. Critical components of a water delivery and distribution system for an HTT water cooled gas turbine rotor were evaluated at typical TRV design conditions of water flow and gravitational force level and the concept and the system validated. Rotor dynamics behavior was not adversely affected by the presence of water in the rotor distribution components. DOE

**N82-26695#** Westinghouse Research and Development Center, Pittsburgh, Pa. Nuclear Components Div.  
**DEVELOPMENT OF AUTOMATED WELDING PROCESS FOR FIELD FABRICATION OF THICK WALLED PRESSURE VESSELS Final Report**

I. STOL 4 Nov. 1981 190 p  
(Contract DE-AC05-78ET-13511)  
(DE82-004421; DOE/ET-13511/T11) Avail: NTIS HC A09/MF A01

Procedure development and qualification for narrow groove gas tungsten arc welding of SA 387 Grade 22 Class 2 steel (2 1/4% Cr-1% Mo) to 4 inch thickness is reviewed. Welding was conducted in the horizontal and vertical position. DOE

**N82-26771#** Midwest Research Inst., Golden, Colo.  
**ASSESSMENT OF SECONDARY RESIDUES. ENGINEERING AND ECONOMIC ANALYSIS Final Report**

A. P. LEUSCHNER, C. E. WEST, and E. ASHARE Aug. 1981 279 p refs  
(Contract DE-AC02-77CH-00178)  
(DE82-000925; SERI/TR-98175-3) Avail: NTIS HC A13/MF A01

Case studies investigating the costs of converting liquid and/or solid secondary agricultural residue streams to methane and/or ethanol. Several economically feasible examples were found: methane production from potato processing liquid residues, ethanol from potato processing solid residues, methane from cheese processing wastes, and methane from poultry processing liquid wastes. In facilities which operate year round, energy recovery is often feasible, whereas in seasonal operations, economic feasibility is not possible. Economic feasibility of energy production from secondary residues is strongly dependent on the current use of the solid and liquid residue. If the solid residue is sold as an animal feed, energy production is usually not economical. High solid and liquid residue disposal costs often make energy conversion economically feasible. DOE

**N82-26911#** California Univ., Livermore. Lawrence Livermore Lab.

**MECHANICAL BEHAVIOR OF MESAVERDE SHALE AND SANDSTONE AT HIGH PRESSURE**

W. LIN Apr. 1981 13 p refs Presented at SPE/DOE Low Permeability Symp., Denver, 27-29 May 1981 Submitted for publication

(Contract W-7405-ENG-48)  
(DE82-001665; UCRL-85808) Avail: NTIS HC A02/MF A01

Rock mechanics measurements taken on Mesaverde shale (source rock) and sandstone (reservoir rock) from about 350 m depth (Colorado) and 1600 m depth (Wyoming) are reported. For each sandstone and shale, the following properties were determined: (1) tensile strength parallel and perpendicular to bedding, 0.1 MPa pressure; (2) triaxial stress failure envelope in compression to 300 MPa confining pressure, parallel and perpendicular to bedding; (3) pressure volume behavior to 1.2 GPa. The results for (1) indicate that, in general, the tensile strength of Wyoming sandstone is about three times that of Colorado sandstone. For both sandstones, the tensile strength is isotropic with respect to bedding. The tensile strength of both shales parallel to bedding is about 30 to 50% greater than that measured normal to bedding. The shale from Wyoming has a tensile strength about 25 to 50% greater than that from Colorado. Strengths and failure modes in compression (2) show that the transition between brittle failure and ductile deformation occurs at a confining pressure of about 0.1 GPa for the Colorado sandstone and 0.25 GPa for all other rocks tested. DOE

**N82-26915#** California Univ., Livermore. Lawrence Livermore Lab.

**SEISMIC AND GEODETIC STUDIES OF THE IMPERIAL VALLEY, CALIFORNIA Final Technical Report**

D. D. JACKSON (UCLA) 1 May 1981 50 p refs

(Contract W-7405-ENG-48)

(DE82-001686; UCRL-15382) Avail: NTIS HC A03/MF A01

Patterns of gravitational and thermal anomalies, strike slip faulting, volcanism in the Imperial Valley were investigated. These patterns suggest that the continental crust may still be spreading. In recent years, the United States Geological Survey and Caltech have added new seismic stations into a dense network in the Imperial Valley to study in detail the relationship between geothermal areas and earthquakes, and to understand the tectonic processes taking place there. The following areas were examined: (1) crustal structure data on P wave arrival times of local earthquakes; (2) leveling data for evidence of tectonic subsidence or uplift; and (3) correlations between seismicity, seismic velocity, geodetic motion, geothermal activity, and local geology. DOE

**N82-27317#** Southwest Research Inst., San Antonio, Tex. Army Fuels and Lubricants Research Lab.

**DEVELOPMENT OF ACCELERATED FUEL-ENGINES QUALIFICATION PROCEDURES METHODOLOGY, VOLUME 1 Interim Report, Oct. 1980 - Sep. 1981**

J. A. RUSSELL, J. P. CUELLAR, JR., J. C. TYLER, J. ERWIN, W. K. KNUTSON, R. A. ALVAREZ, R. L. STENBERG (Army Aviation Research and Development Command), F. O. ZIMMER (Army Aviation Research and Development Command), R. L. RENTA (Mueller Associates, Inc.), and T. J. TIMBARIO (Mueller Associates, Inc.) Dec. 1981 216 p refs 2 Vol.

(Contract DAAK70-81-C-0209; DAAK70-80-C-0001;

DAAK70-82-C-0001; DA PROJ. 1L2-63104-D-150)

(AD-A113461; AFLRL-144-VOL-1) Avail: NTIS HC A10/MF A01 CSDL 15E

Activities and findings are reported for a 12-month program aimed at the development of procedures for accelerating the qualification of new fuels on Army equipment, emphasizing those derived from oil shale and coal. Principal activities were identification of key tactical and combat surface and air vehicles, powerplants, and fuels systems components; identification of critical properties peculiar to new fuels anticipated to have significant impact upon Army materiel; laboratory evaluations of materials compatibility and fuels characteristics (including lubricity, elastomer compatibility, thermal stability, and corrosion); full-scale fuel systems component testing, and an overall review and evaluation of existing engine/fuel system qualification procedures. Conclusions and recommendations are presented in terms of methodology and criteria which will realistically address key peculiarities of alternative fuels and thus serve to accelerate their qualification for field Army use. Author (GRA)

**N82-27318#** Southwest Research Inst., San Antonio, Tex. Army Fuels and Lubricants Research Lab.

**DEVELOPMENT OF ACCELERATED FUEL-ENGINES QUALIFICATION PROCEDURES METHODOLOGY. VOLUME 1: APPENDICES Interim Report, Oct. 1980 - Sep. 1981**

J. A. RUSSELL, J. P. CUELLAR, JR., J. C. TYLER, J. ERWIN, R. A. ALVAREZ, W. K. KNUTSON, R. L. STENBERG (Army Aviation Research and Development Command), F. O. ZIMMER (Army Aviation Research and Development Command), R. L. RENTZ (Mueller Associates, Inc.), T. J. TIMBARIO (Mueller Associates, Inc.) et al. Dec. 1981 438 p 2 Vol.

(Contract DAAK70-81-C-0209; DAAK70-82-C-0001;

DAAK70-80-C-0001)

(AD-A113532; AFLRL-144-VOL-2) Avail: NTIS HC A19/MF A01 CSDL 15E

Aircraft engine component listings are included, along with elastomer swell and hardness data and retention properties. Several shale oil fuel test plans are presented. Pre and post test definition data, spot calibration, flow test, fuel characteristics, lubricity and interfacial tension data are also given. Component test results, disassembly and inspection, identification of critical

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fuel system components, and existing engine qualification procedures are also included. S.L.

**N82-27451#** Gulf Research and Development Co., Pittsburgh, Pa.

**INVESTIGATION OF MECHANISMS OF HYDROGEN TRANSFER IN COAL HYDROGENATION Quarterly Progress Report, Mar. - Jun. 1981**

D. C. CRONAUER Sep. 1981 52 p refs

(Contract DE-AC22-80PC-30080)

(DE82-004407; DOE/PC-30080/5) Avail: NTIS HC A04/MF A01

Model compound and coal liquefaction experiments were carried out in a stainless steel tubular reactor at 4500 C to observe the effects of hydrogen transfer on solvent isomerization. Significant observations are that: (1) methylindan production from tetralin in the presence of dibenzyl took place by at least two different mechanisms, only one of which involved the normal cracking dibenzyl; (2) deuterium hydrogen isotope studies with model compounds and coal liquefaction indicated that kinetic data from the model compound experiments should be applied to coal liquefaction only with caution; and (3) solvent isomerization by ring contraction is a problem in recycle operation due to the low hydrogen donor capability and exceptional stability of the rearranged product. DOE

**N82-27453#** Colorado School of Mines, Golden. Dept. of Chemical and Petroleum Refining Engineering.

**MECHANISMS AND KINETICS OF COAL HYDROGENATION Quarterly Progress Report, Jul. - Sep. 1981**

R. M. BALDWIN Oct. 1981 52 p

(Contract DE-AC22-79ET-14881)

(DE82-004867; DOE/ET-14881/7) Avail: NTIS HC A04/MF A01

A coal hydrogenation research project is described. The rates of coal hydrogenation in continuous flow stirred tank and tube flow reactors using pure hydrogen, catalyzed CO-STEAM, and syngas processing conditions are compared. The influence of coal properties on the rate of hydrogenation of coal to preasphaltenes, asphaltenes, and oil in batch reactors is studied. The effect of operating conditions (temperature, added catalysts, and pressure) on the rate of hydrogenation of coal derived preasphaltenes and asphaltenes is studied. The effect of selected disposable catalysts on the rate of batch hydrogenation of selected bituminous coals is studied. Promising catalyst systems in the continuous processing units are tested. A unified kinetic/mechanistic model was formulated for coal liquefaction taking into account petrography of the feed coal and hydrocarbon lumps in the product oil. DOE

**N82-27454#** Pittsburgh and Midway Coal Mining Co., Shawnee Mission, Kans.

**RESEARCH ON SOLVENT REFINED COAL Quarterly Technical Progress Report, 1 Jan. - 31 Mar. 1981**

Nov. 1981 67 p

(Contract DE-AC22-81PC-40005)

(DE82-004535; DOE/PC-40005/1) Avail: NTIS HC A04/MF A01

Pittsburgh seam coals from the Powhatan No. 3, Powhatan No. 6, McElroy, Robinson Run and a blend of coals from the Powhatan No. 6 and Ireland Mines were evaluated as feedstocks for major liquefaction facilities. Yields and operability with all of these coals were found to be generally satisfactory at normal SRC II operating conditions. In addition, a series of runs was conducted in the SRC II mode with Pittsburgh seam coal from the Powhatan No. 5 Mine at conditions expected to produce high oil yields. Oil yield was increased and SRC yield decreased significantly by increases in pressure, residence time and recycle solids levels over those normally used. T.M.

**N82-27456#** Physical Sciences, Inc., Woburn, Mass.

**PULVERIZED-FUEL COMBUSTION: MODELING AND SCALEUP METHODOLOGIES Quarterly Report, 1 Jul. - 30 Sep. 1981**

P. F. LEWIS and N. H. KEMP Dec. 1981 18 p refs

(Contract DE-AC22-80PC-30294)

(DE82-004790; DOE/PC-30294/4; QR-4) Avail: NTIS HC A02/MF A01

Models of small to medium scale pulverized fuel combustors were developed. Scaling laws for flame stability and carbon carry over were developed also. Work was confined to the data analysis task. A sample computation and the influence of various phenomena on the results are discussed. T.M.

**N82-27459#** National Bureau of Standards, Washington, D.C.

**MODELLING OF OIL SHALE RETORTS FOR ELECTROMAGNETIC SENSING TECHNIQUES Final Report**

H. CHEW Nov. 1981 48 p refs Sponsored in part by DOE Clarkson College, Potsdam, N.Y.)

(PB82-153321; NBSIR-81-1653) Avail: NTIS HC A03/MF A01 CSCI 07A

The feasibility of determining the void ratio of oil shale retorts by remote electromagnetic measurement is evaluated. The retort is modelled by a spheroid with an average dielectric constant which depends on the void ratio. The near field due to a radiating dipole source in the vicinity of a spheroidal retort is computed using the extended boundary condition method of Waterman, Barber, and Yeh. Numerical results are given at 4 MHz for a retort with major axis 45.7 (150 ft), minor axis 25.1 m (82.5 ft), bulk dielectric constant  $8.8 \pm 3.7$ , and various void ratios. GRA

**N82-27516#** Bayerisches Geologisches Landesamt, Munich (West Germany).

**THE BOREHOLES ORTENBURG 1 AND 2 (1980/81) Final Report**

H. GUDDEN and H. SCHMID Bonn Bundesministerium fuer Forschung und Technologie Feb. 1982 35 p refs In GERMAN; ENGLISH summary Sponsored by Bundesministerium fuer Forschung und Technologie

(BMFT-FB-T-82-004; ISSN-0340-7608; REPT-203.1.8-IV/2C)

Avail: NTIS HC A03/MF A01; Fachinformationszentrum, Karlsruhe, West Germany DM 7,40

Prospecting on the Ortenburg plateau is described. Permian and mesozoic sedimentary rocks of the variscan orogene area are often U, Cu, Pb and Cu bearing, especially layers of reduced thickness and reducing environment as well as the border between crystalline basement and overlying rocks. The outcrops of these rocks are well investigated except where the prospected series are covered by younger formations. The few borings in this region corroborate their interest. Therefore, the boreholes Ortenburg 1 and 2 were sunk, reaching the crystalline basement by a 1 m clastic layer, under tertiary, cretaceous and mesozoic rocks. Chemical analyses show amounts up to 0.15% Pb and 0.1% Cu in the weathered basement and the clastic layer. At the basement top there are peaks in the Gamma Log with intensities of 2x to 3x crystalline background. Author (ESA)

**N82-27520#** Georgetown Univ., Washington, D.C. Dept. of Chemistry.

**FRACTIONATION OF DIESEL FUEL FROM PETROLEUM AND PARAHIO SHALE OILS Final Report**

C. F. HAMMER Oct. 1981 22 p refs

(Contract N00167-76-M-8549; ZF45451001)

(AD-A107042; DTNSRDC/SME-80/212) Avail: NTIS HC A02/MF A01 CSCI 21D

A fractionation scheme has been developed to separate diesel fuels into neutral water solubles, acidic components, basic components, saturated hydrocarbons, substituted benzenes, polycyclic aromatic hydrocarbons, and polar neutrals. A sample of conventional petroleum diesel fuel and a sample of diesel fuel derived from Paraho crude shale oil by the Gary-Western process were fractionated by this procedure. Each fraction was further analyzed by gas chromatography and proton magnetic resonance spectroscopy. The petroleum sample was found to contain 17.5%

total aromatics of which 9.5% were polycyclic aromatic hydrocarbons compounds. However, the Paraho-Gray Western shale oil fuel contained about twice as much total aromatics (38.2%) and polycyclic aromatic hydrocarbons compounds (19.3%). The total acyclic hydrocarbon straight chain compounds content was 66.7% for the petroleum sample and 59.3% for the Paraho-Gray Western shale sample. Suggestions for further work are also made. Author (GRA)

**N82-27522#** Southwest Research Inst., San Antonio, Tex. Army Fuels and Lubricants Research Lab.

**SUITABILITY OF SHALE FUELS FOR ARMY GENERATOR SETS**  
**Interim Report, May 1980 - Sep. 1981**

A. F. MONTEMAYOR Dec. 1981 69 p refs  
(Contract DAAK70-80-C-0001; DAAK70-82-C-0001; DA PROJ. 1L7-62733-AH-20)  
(AD-A112609; AFLRL-142) Avail: NTIS HC A04/MF A01 CSCL 21D

Gasoline, diesel, and gas turbine generator sets were examined to determine which shale fuel properties might adversely affect their performance. Information from engine manufacturers, fuel system manufacturers, U.S. Army Troop Support and Aviation Readiness Command (USATSARCOM) personnel and existing literature was consulted to identify existing/potential problems. Known shale fuel properties were presented and compared to military specifications. Generator sets were separated into major grouping by the fuel systems they employ. A listing of generator sets was included in order to facilitate generator set selection for testing. In general, the performance of shale fuels seemed to be comparable to that of petroleum fuels. Long-term problems such as elastomer degradation, poor life, and difficult cold weather starting may manifest themselves if refiners are unable to meet military specifications. Based on the fuels produced to date, refiners should be able to meet specifications and provide shale fuels suitable for generator set operation. Several fuel properties not covered in military specifications (such as lubricity and hydrocarbon composition) were seen as potential problem areas. A recommended test procedure has been provided to test the areas of concern presented in this report. Author (GRA)

**N82-27523#** Amoco Oil Co., Naperville, Ill. Research and Development Dept.

**EVALUATION OF HYDROCRACKING CATALYSTS FOR CONVERSION OF WHOLE SHALE OIL INTO HIGH YIELDS OF JET FUELS** Final Report, Dec. 1979 - Oct. 1981

A. M. TAIT and A. L. HENSLEY Wright-Patterson AFB, Ohio AFWAL Oct. 1981 196 p refs  
(Contract F33615-79-C-2095; AF PROJ. 3048)  
(AD-A112820; M81-65; AFWAL-TR-81-2098) Avail: NTIS HC A09/MF A01 CSCL 21D

A catalyst development and screening program has led to a formulation capable of upgrading whole shale oil into high yields of military jet fuel in a single operation. The catalyst is multifaceted in its functionality in that it sequentially saturates, denitrogenates, and hydrocracks the feedstock in the presence of high levels of contaminants, such as organic nitrogen compounds and ammonia, while maintaining a high selectivity towards jet-fuel, boiling range material. The catalyst, developed by optimization of both chemical and physical properties, consists of 1.5% cobalt oxide, 10% chromium oxide, and 15% molybdenum oxide on a support of 50% ultrastable molecular sieve in alumina. The effectiveness of the catalyst for the direct upgrading of an Occidental whole shale oil was demonstrated in a 100-day test. The feed, containing approximately 15 weight percent material boiling within the range for JP-4 and containing 13,000 ppm nitrogen, was upgraded to a water-white product containing 1 to 3 ppm nitrogen and approximately 75% JP-4 material. The hydrogen consumption required for this level of upgrading and conversion was approximately 1800 SCFB. The catalyst developed represents an advance in shale oil upgrading technology over more conventional petroleum-based technology. Author (GRA)

**N82-27524#** Simmonds Precision Products, Inc., Vergennes, Vermont.

**COMMERCIAL AIRCRAFT AIRFRAME FUEL SYSTEMS**  
**SURVEYS Interim Report, Oct. 1980 - Oct. 1981**

P. G. WEITZ Atlantic City FAA Feb. 1982 55 p refs  
(Contract DTFA03-80-C-0080)  
(AD-A112241; E-2304; FAA-CT-82-12) Avail: NTIS HC A04/MF A01 CSCL 20D

A selection of commercial aircraft airframe fuel systems has been studied to determine areas where incompatibility with antimisting kerosene fuel (AMK) may exist. Incompatibility can be due to reduced fuel system component performance with AMK or shear degradation of the AMK by the fuel system components. Survey results, to date, indicate that potential component performance problems with AMK are more significant than loss of AMK flammability protection due to shear degradation. Components of interest include ejector pumps, fuel filters, and auxiliary power units. The solubility of water in AMK and its effect on fuel system performance under actual operating conditions is also of major importance. Author (GRA)

**N82-27530#** Department of Energy, Bartlesville, Okla. Energy Technology Center.

**LIQUID FOSSIL FUEL TECHNOLOGY** Quarterly Technical Progress Report, Apr. - Jun. 1981

Oct. 1981 72 p  
(DE82-004725; DOE/BETC/QPR-81/2) Avail: NTIS HC A04/MF A01

Highlights of progress made during the quarter ending June, 1981, are presented. Cation exchange capacity of oil and gas wells was determined using a semi-automated procedure. The equivalent alkane carbon number (EACN) was determined for Delaware-Childers oil. It was shown that for this oil, the type of surfactant and alcohol used causes the EACN to vary on unusual amount. Arsenic compounds from samples of Green River oil shale kerogen was identified (both inorganic and organometallic compounds). The concepts of adsorption isotherm, used for determining the thermodynamic properties of surfactant systems, has undergone some changes in order to better represent the physical model. A derivation of the new ideas and their application to immersion measurements are described. A method for analysis of alcohols in water, hydrocarbon mixtures, or exhaust gases was developed. The method, which utilizes two gas chromatographs, analyzes methanol, ethanol, and other alcohols up through the C4 group. DOE

**N82-27532#** Stearns-Roger Corp., Denver, Colo.

**BI-GAS PILOT PLANT** Quarterly Technical Progress Report, 1 Jan. - 31 Mar. 1981

1981 80 p refs  
(Contract DE-AC01-80ET-14705)  
(DE82-004753; DOE/ET-14705/26) Avail: NTIS HC A05/MF A01

The plant is designed to process a maximum of 5 tons per hour of coal. It is a facility designed to study all phase of coal conversion to high BTU, pipeline quality gas. This particular staged concept of gasification was originated primarily to maximize the yield of methane. Considerable methane is produced as the coal is devolatilized. DOE

**N82-27534#** Engineering-Science, Inc., Arcadia, Calif.

**ANALYSIS OF POTENTIAL METHODS TO DETERMINE VOLATILITIES OF HEAVY CRUDE OILS** Final Report

R. J. BRYAN Dec. 1981 60 p refs  
(Contract EPA-68-02-3509)  
(PB82-145384; EPA-909/9-81-004) Avail: NTIS HC A04/MF A01 CSCL 21D

Alternative methods to measure the volatility of heavy crude oil are discussed. The work was restricted to a literature search and inquiries made to informed government and industry groups. Methods investigated include developing data to extend the temperature and vapor pressure range of the correlation nomograph, modifying the Reid vapor pressure method, use of a

## 04 FUELS AND OTHER SOURCES OF ENERGY

vapor composition approach, and determining evaporation losses under controlled conditions. Sampling and analytical problems were evaluated for the alternatives. A recommendation was made to conduct further studies on the vapor composition method. GRA

**N82-27535#** Water Resources Council, Washington, D.C.  
**SYNTHETIC FUELS DEVELOPMENT IN THE UPPER COLORADO REGION: SECTION 13(A) WATER ASSESSMENT REPORT**

Jul. 1981 138 p refs

(PB82-156761) Avail: NTIS HC A07/MF A01 CSCL 13B

The following general conclusions and major specific findings were reached during the course of the water assessment for the Upper Colorado region. The production of synthetic fuels in the Upper Colorado River region by the extraction and processing of oil shale and/or coal, will require significant quantities of water. The overall supply of ground and surface water resources in the region is sufficient to accommodate a synthesis production level of nearly 3 million barrels oil equivalent per day. While the gross water supplies in the region are sufficient for accelerated synfuels development, water supply problems are apparent in some areas. GRA

**N82-27798#** Geokinetics, Inc., Salt Lake City, Utah.  
**INVESTIGATION OF THE GEOKINETICS HORIZONTAL IN SITU OIL SHALE RETORTING PROCESS Quarterly Report, Jul. - Sep. 1981**

J. R. GILBERT Nov. 1981 30 p refs

(Contract DE-FC20-78LC-10787)

(DE82-004273; DOE/LC-10787/86) Avail: NTIS HC A03/MF A01

The development of an in-situ process for recovering shale oil is reported. A retort No. 26 was loaded with explosives on August 5 and 6. On August 7, retort No. 26 was detonated. The retort No. 26 blast was highly successful. Following the blast of retort No. 26 preparations are made for the ignition of retort No. 25. Equipment and piping were set in place and the instrumentation systems were wired in. Ignition for retort No. 25 is scheduled for mid to late October 1981. The retort No. 26 Postblast coring program continues. With the ignition of retort No. 25 the analytical lab began constant monitoring of the retort burn. DOE

**N82-27801#** Engineers International, Inc., Downers Grove, Ill.  
**INVESTIGATION OF PROBLEMS AND BENEFITS OF UNDERGROUND MULTIPLE SEAM COAL MINING Final Technical Report**

M. M. SINGH and M. F. DUNN Washington DOE Oct. 1981 325 p refs

(Contract DE-AC01-79ET-14242)

(DE82-002807; DOE/ET-14242/T2) Avail: NTIS HC A14/MF A01

It is estimated that over 156 billion tons of coal in the United States are amenable to multiple-seam mining. However, currently most operations mine only a single seam, and in the past indiscriminate practices have sterilized large amounts of coal in contiguous seams. In the interests of conservation, it is imperative that procedures be followed that enhance resource recovery. The total life-cycle costs of mining are site specific because of the wide variations in land acquisition costs, capital expenditures, resource recovery, labor productivity, and geological conditions. However, under similar circumstances the costs of single- and multiple-seam mining are within 5 percent, using the best available technology. Improvements in present methods could lower costs of multiple-seam mining further, making it more competitive. Ground control (entailing roof support, bumps, and subsidence) is the most important technical problem encountered in multiple-seam mining, mainly caused by remnant pillars. DOE

**N82-27804#** Western Geophysical Co. of America, Houston, Tex. Aero Service Div.

**AIRBORNE GAMMA-RAY SPECTROMETER AND MAGNETOMETER SURVEY: NORTH/SOUTH TIELINE, VOLUME 1 Final Report**

May 1981 38 p refs 2 Vol.

(Contract DE-AC13-76GJ-01664)

(DE82-005542; GJBX-386-81-VOL-1) Avail: NTIS HC A03/MF A01

An airborne high sensitivity gamma ray spectrometer and magnetometer survey was conducted along the 990 longitude meridian from the Canadian border southward to the Mexican border. A total of 1555 line miles of geophysical data were acquired. The program acquires and compiles geologic and other information to assess the magnitude and distribution of uranium resources and to determine areas favorable for the occurrence of uranium in the United States. DOE

**N82-27805#** Western Geophysical Co. of America, Houston, Tex. Aero Service Div.

**AIRBORNE GAMMA-RAY SPECTROMETER AND MAGNETOMETER SURVEY: NORTH/SOUTH TIELINE, VOLUME 2 Final Report**

May 1981 108 p refs 2 Vol.

(Contract DE-AC13-76GJ-01664)

(DE82-005570; GJBX-386-81-VOL-2) Avail: NTIS HC A06/MF A01

Data from an airborne high sensitivity gamma-ray spectrometer and magnetometer survey along the 990 longitude meridian from the Canadian border southward to the Mexican border are presented. The purpose of this study is to acquire and compile geologic and other information with which to assess the magnitude and distribution of uranium resources and to determine areas favorable for the occurrence of uranium in the US. DOE

**N82-27808#** Texas Univ., El Paso. Dept. of Geological Sciences.

**EVALUATION AND COMBINED GEOPHYSICAL INTERPRETATIONS OF NURE AND RELATED GEOSCIENCE DATA IN THE VAN HORN, PECOS, MARFA, FORT STOCKTON, PRESIDIDO, AND EMORY PEAK QUADRANGLES, TEXAS, VOLUME 1 Final Report**

G. R. KELLER, W. J. HINZE, C. L. V. AIKEN, P. C. GOODELL, R. F. ROY, and N. E. PINGITORE Sep. 1981 451 p refs 2 Vol.

(Contract DE-AC13-76GJ-01664)

(DE82-005554; GJBX-365-81) Avail: NTIS HC A20/MF A01

The six Trans-Pecos Texas quadrangles (Van Horn, Pecos, Marfa, Fort Stockton, Presidio, and Emory Park) were surveyed. The aeromagnetic gravity and geochemical data, their processing, and their analysis are discussed. The geologic history and setting of the Trans-Pecos are discussed along with the uranium potential of the region. Uranium anomalies and occurrences are present in the study area, and information is presented on 33 drill holes into these targets. A folio of maps reduced to a scale of 1:500,000. Geologic maps for each of the six quadrangles are included and the geophysical maps have been prepared to be overlays for the geologic maps. Residual aeromagnetic anomaly, complete Bouguer gravity anomaly, flight line index, gravity station index, and anomaly interpretative maps were prepared for each quadrangle. A large suite of digitally processed maps of gravity and aeromagnetic are included. DOE

**N82-27829#** Applied Physics Lab., Johns Hopkins Univ., Laurel, Md.

**A PROGRAM FOR SINGLE-PHASE MODERATE-TEMPERATURE GEOTHERMAL WELL DRAWDOWN AND PUMPING ENERGY FOR THE HP-97 AND OTHER DESK CALCULATORS**

K. YU and R. VONBRIESEN Nov. 1981 18 p refs  
(Contract DE-AI01-79ET-27025; EX-76-A-1008)  
(PB82-148420; JHU/APL/QM-81-138) Avail: NTIS HC A02/MF A01 CSCL 08I

A desk calculator program was developed to provide a simple hydrologic model that could be used by those interested in the preliminary sizing of withdrawal rates and schedules for geothermal wells. The program was of considerable use in technical assistance projects along the Atlantic Coastal Plain. The program output is in the form of a listing that shows the incrementation years with the appropriate drawdown and the total pumping energy for each year. GRA

**N82-27834#** Dunn Geoscience Corp., Latham, N.Y.  
**ANALYSIS OF POTENTIAL GEOTHERMAL RESOURCES AND THEIR USE: LEBANON SPRINGS, NEW YORK**

J. R. DUNN and W. E. CUTCLIFFE Apr. 1981 59 p  
(PB82-147380; NYSERDA-81-4) Avail: NTIS HC A04/MF A01 CSCL 08G

In addition to geologic mapping of the Lebanon Springs area and Williamstown, Massachusetts area, thermal gradients were measured in 25 abandoned water wells in the area. The silica content and water temperatures of 78 active domestic water wells were determined. T.M.

**N82-27841#** Sandia Labs., Albuquerque, N. Mex.  
**GEOTHERMAL POTENTIAL ON KIRTLAND AIR FORCE BASE LANDS, BERNALILLO COUNTY, NEW MEXICO**

P. R. GRANT, JR. (Energy Resources Exploration, Inc.) Oct. 1981 65 p refs  
(Contract DE-AC04-76DP-00789)  
(AD-A107044; SAND-81-7141) Avail: NTIS HC A04/MF A01 CSCL 08H

Public policy expressed in a number of national directives in recent years stresses the conservation of conventional fuel supplies, a switch to alternative fuels, and the application of advanced energy technologies at federal installations. Natural gas currently furnishes 85 to 95 percent of the average 94 x 1,000,000 Btu/hr energy requirements for space heating and cooling at Kirtland Air Force Base. Studies of alternatives to the use of natural gas at the base include examination of the geothermal option. Four of North America's major physiographic provinces coalesce in central New Mexico on or near Kirtland AFB. Their junction is identified throughout much of this region by a tectonic depression occupied by the Rio Grande that is structurally complex, stratigraphically and hydrologically unique, and coincides with geologically recent volcanic centers. This trough, the Rio Grande rift, has been identified as a major geothermal resource area. The western part of Kirtland AFB is in the Albuquerque Basin segment of the Rio Grande rift. Extensive sampling and geochemical analysis of groundwater in and near the base disclosed no significant geothermal parameters. However, structural conditions and current hydrologics regimes strongly suggest that thermal waters would be masked by near surface, low temperature meteoric water originating as rain and snowfall in the nearby mountains. GRA

**N82-27857#** Bayerisches Landesamt fuer Wasserwirtschaft (West Germany).

**INVESTIGATION INTO THE ECONOMY OF METHANE GAS UTILIZATION IN SEWAGE TREATMENT PLANTS Final Report**

P. WOLF Bonn Bundesministerium fuer Forschung und Technologie Mar. 1982 154 p refs In GERMAN; ENGLISH summary Sponsored by Bundesministerium fuer Forschung und Technologie  
(BMFT-FB-T-82-025; ISSN-0340-7608) Avail: NTIS HC A08/MF A01; Fachinformationszentrum, Karlsruhe, West Germany DM 32

The economic feasibility of methane gas utilization in small and medium sized sewage treatment plants was studied. Assuming

that rising energy costs make this energy source attractive, existing and theoretical model plants of various sizes were investigated by considering different price scales for electric power and fuel oil. This was done with variation of the kind of biological sewage treatment, sludge treatment, and of kinds and facilities of methane gas utilization. Results show that using methane gas for power generation is relatively economic in comparison to alternative methods of gas utilization for treatment plants bigger than 50,000 population equivalent. Author (ESA)

**N82-27859#** Pacific Northwest River Basins Commission, Vancouver, Wash.

**WATER AND EMERGING ENERGY TECHNOLOGIES: SUMMARY REPORT**

Mar. 1981 106 p Sponsored in part by Water Resources Council, Washington, D.C.  
(PB82-153123) Avail: NTIS HC A06/MF A01 CSCL 13B

An assessment of possible energy development in structural basins of the Pacific Northwest is presented. The energy technologies examined include small hydro, geothermal electric, geothermal heat, biomass/cogeneration, and coal gasification. T.M.

**N82-27860#** Pacific Northwest River Basins Commission, Vancouver, Wash.

**WATER AND EMERGING ENERGY TECHNOLOGIES**

Mar. 1981 139 p Sponsored in part by Water Resources Council, Washington, D.C.  
(PB82-153131) Avail: NTIS HC A07/MF A01 CSCL 13B

In 1977, the Department of Energy requested that the Water Resources Council undertake the required assessments whereupon development of Section 13(a) assessments were begun in the Missouri River, Ohio River, and upper Colorado River Basins. In September 1979, a Memorandum of Agreement between the Water Resources Council and Pacific Northwest River Basins Commission initiated an assessment in the Pacific Northwest. This report documents the findings and conclusions of that 13(a) assessment are presented. GRA

**N82-27884#** Conference of Radiation Control Program Directors, Inc., Rockville, Md.

**NATURAL RADIOACTIVITY CONTAMINATION PROBLEMS Final Report**

Sep. 1981 134 p refs Prepared in cooperation with Nuclear Regulatory Commission  
(Contract PHS-223-79-6010; EPA-IAG-D7-0968)  
(PB82-140443; NCRCPD-1; FR-2) Avail: NTIS HC A07/MF A01 CSCL 18H

Levels of naturally occurring radionuclides associated with the bauxite, columbium-tantalum, phosphate, tin, pumice, and titanium mineral extraction industries are reported. Data is also presented on radioactivity measurements in ground water, in selected geothermal waters, and in oil production brines. Radiation protection guidance is provided for uranium recovery from wet-process phosphate plants, for soil contamination limits, and for radiological exposure in natural caves. Dose pathways from incidental uses of naturally occurring radioactive materials are presented. Model state regulations for protecting public health and safety from use and disposal of naturally occurring radioactive material are outlined. GRA

**N82-27909#** Geological Survey, Reston, Va. Office of Energy Resources.

**SHALE CHARACTERIZATION AND RESOURCE APPRAISAL OF DEVONIAN BLACK SHALES OF THE APPALACHIAN BASIN Monthly Report for October 1981**

W. DEWITT, JR. Oct. 1981 12 p  
(Contract DE-AI21-79MC-10866)  
(DE82-004191; DOE/MC-10866/T10) Avail: NTIS HC A02/MF A01

Department of Energy funds for the US Geological Survey's characterization and approval program were exhausted. Final reports for 4 of the 9 projects of the program were released to

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METC during FY 1981. Monthly progress reports will continue to be submitted to DOE until the last of the program work is completed and the last of the project final reports submitted to METC.

DOE

## 05

### ENERGY CONVERSION

Includes thermomechanical, thermoelectric, geothermal, ocean thermal, and wind energy conversion. Also includes nuclear reactors, magnetohydrodynamic generators, and fuel cells.

**A82-28587**

#### THE GAS TURBINE ENGINE

D. DRIVER, D. W. HALL, and G. W. MEETHAM (Rolls-Royce, Ltd., Derby, England) In: The development of gas turbine materials. London, Applied Science Publishers, 1981, p. 1-30. refs

An historical account is given of the developments in gas turbine engine mechanical design which, by increasing operating temperature requirements in their evolution towards greater thrust and lower fuel consumption, have strongly affected the choice of component materials. The desire to reduce powerplant weight, and especially the weight of rotating components, has also been a significant factor in the development of materials. Compressor materials, which were largely aluminum alloy in the earliest gas turbine engines, were supplanted by steels as temperatures rose above 200 C in the early 1950s; the development of high specific strength titanium alloys led to their application to compressor blades and casings after 1960. Combustion chamber and turbine materials have been a succession of increasingly corrosion-resistant nickel-based superalloys. Attention is also given to drive shafts and bearings.

O.C.

**A82-29070#**

#### APPROACH TO THE REALIZATION OF A CLOSED CYCLE OCEAN THERMAL ENERGY CONVERSION /OTEC/ SYSTEM

T. KAJIKAWA Electrotechnical Laboratory, Researches, no. 206, Aug. 1981. 225 p. In Japanese, with abstract in English. refs

The design and operational features and goals of a Japanese 1 MWe Ocean Thermal Energy Conversion (OTEC) demonstration plant are described. Japan research and development efforts in OTEC systems are reviewed, along with results which have encouraged the decision to construct the demonstration plant. The plant is being designed for implementation in the seas around Japan, is required to function for 6 mos/yr, and will provide engineering data on the performance of both tube and shell type heat exchangers. The initial test will be run using Freon 22 as the working fluid, followed by NH<sub>3</sub> in subsequent trials. The system will be barge-mounted and have a cooling water pipe fixed by single-point mooring. Mainly a proof of principle in large-scale OTEC, the plant will provide a test bed for environmental monitoring and power transmission through the sea, and will serve as a model for a 10 MWe plant.

M.S.K.

**A82-29738**

#### ALFVEN-WAVE GENERATION IN A BEAM-PLASMA SYSTEM

P. K. SHUKLA (Bochum, Ruhr-Universitaet, Bochum, West Germany) and R. P. SHARMA (Bochum, Ruhr-Universitaet, Bochum, West Germany; Indian Institute of Technology, New Delhi, India) Physical Review A - General Physics, 3rd Series, vol. 25, May 1982, p. 2816-2819. refs

This paper considers nonlinear decay of a beam-driven plasma mode into an Alfvén wave plus a circularly polarized electromagnetic wave near the electron-plasma frequency. Explicit expressions for the growth rate and threshold are obtained analytically. Relevance of our work to space as well as laboratory plasmas is discussed.

(Author)

**A82-29793**

#### FUTURE AUTO ENGINES - COMPETITION HEATS UP

C. RAIN High Technology, vol. 2, May-June 1982, p. 39-47.

The conventional internal combustion engine will remain an important factor in future automobile engines because it is perfectly suited to the widely varying conditions of city and highway driving, and engineers continue to eke out design advances. Diesels will continue to make strong gains in the near term because of their fuel economy advantage, but their emissions and fuel requirement problems are serious. Stratified charge engines could challenge the diesel because they satisfy governmental goals and would require the lowest retooling costs. Their multifuel capability gives them long-term viability. The gas turbine and the Stirling offer the best fuel economies and are clean-burning, and both run on a wide range of fuels. The Stirling requires engineering to improve its power density and to cut costs, while the gas turbine needs a breakthrough in durable high-temperature ceramics.

C.D.

**A82-30331**

#### ENERGY RELATED OPTICAL COATINGS

A. THELEN (Optical Coating Laboratory, Inc., Santa Rosa, CA) Journal of Vacuum Science and Technology, vol. 20, Mar. 1982, p. 310-315. refs

Current applications of optical coatings to improve the efficiency of energy conversion are reviewed. Conversion both into optical energy (energy efficient lighting, regenerative lamps) and from optical energy (architectural coatings, for photothermal and photovoltaic converters, laser fusion coatings) is discussed. The impact of advanced roll coating technology is assessed.

(Author)

**A82-30866**

#### ON THE SPECTRAL ENERGY AND POWER COMPONENTS IN HORIZONTAL WIND GUSTS

P. R. BARKER and G. J. BOWDEN (New South Wales, University, Kensington, Australia) Wind Engineering, vol. 6, no. 1, 1982, p. 1-11. refs

**A82-30868**

#### POWER OPTIMIZATION OF WIND ELECTRIC CONVERSION SYSTEMS INTEGRATED INTO THE UTILITY GRID

K. KALAITZAKIS and G. VACHTSEVANOS (Thrace, University, Xanthe, Greece) Wind Engineering, vol. 6, no. 1, 1982, p. 24-36. refs

**A82-30869**

#### A FREQUENCY AND DURATION METHOD FOR THE EVALUATION OF WIND INTEGRATION

A. J. JANSSEN (Netherlands Energy Research Foundation-ECN, Petten, Netherlands) Wind Engineering, vol. 6, no. 1, 1982, p. 37-58. refs

The theory and extent of applicability of a frequency and duration (FD) method for reliability and energy production studies of wind-assisted utility power systems are detailed. Inputs to the FD are the frequencies and durations of system load levels and forced outages of the production units, which are ranked from base to peak loads. Scheduled down times are added to the calculations to form a model for a perfectly reliable system of units subjected to a random load. An algorithm is developed for evaluation of the effective load, and uncertainties in predictions of annual peak loads are included. A two-state Markov model for the production units is presented and a generalization for multistage generators is made for cases when correlations do and do not exist in the temporal variability of the system load and the intermittent wind energy source. The limited operating flexibility of the wind turbines indicates that some thermal power capacity be given priority as base load units while large scale windfarm development may result in the reduction of the total number of base load plants and an increase in the number of peaking plants.

M.S.K.

A82-31572

**RELIABILITY ANALYSIS OF COMBINED WIND-ELECTRIC AND CONVENTIONAL GENERATION SYSTEMS**

R. G. DESHMUKH (Memphis State University, Memphis, TN) and R. RAMAKUMAR (Oklahoma State University, Stillwater, OK) Solar Energy, vol. 28, no. 4, 1982, p. 345-352. Research supported by the Oklahoma State University and Memphis State University. refs

Probabilistic models for wind-electric conversion systems and their use in the reliability studies of combined wind-electric and conventional generation systems are discussed. Representative numerical results for a typical site in Hawaii for the month with an excellent wind regime are presented. The results and discussions documented in this paper should be helpful in the planning and incorporation of wind-electric systems as a component in the generation mixes of the utility systems of the future. (Author)

A82-31843

**THE THERMODYNAMICS OF ELECTROLYTE DISTRIBUTION IN MOLTEN CARBONATE FUEL CELLS**

R. H. ARENDT (GE Physical Chemistry Laboratory, Schenectady, NY) Electrochemical Society, Journal, vol. 129, May 1982, p. 942-946. refs

The fundamental thermodynamic relations governing the behavior of a fluid phase residing within the interstices of a porous solid phase are reviewed. The relationships are applied to the problem of electrolyte distribution among the components of the molten carbonate fuel cell. This distribution is of paramount importance in determining cell electrochemical performance. In addition, the function of the electrolyte structure, or 'tile,' as a gas impermeable partition between the anode and cathode environment is considered. (Author)

A82-31844

**ALTERNATE MATRIX MATERIAL FOR MOLTEN CARBONATE FUEL CELL ELECTROLYTE STRUCTURES**

R. H. ARENDT (GE Physical Chemistry Laboratory, Schenectady, NY) (Electrochemical Society, Meeting, Hollywood, FL, Oct. 5-10, 1980.) Electrochemical Society, Journal, vol. 129, May 1982, p. 979-983. refs

(Contract DE-AC03-77ET-11319)

The preparation and physicochemical characteristics of SrTiO<sub>3</sub> crystallites suitable for use as the matrix for liquid alkali carbonates in fuel cells are presented. The preparation utilizes a fugitive molten alkali chloride solvent to effect product formation. The product, following separation from the reaction medium, is composed of submicron, relatively uniformly shaped and sized, monodispersed crystallites. Data are presented on the utilization of this material in both hot-pressed and impregnation fabricated electrolyte structures. Data from the preliminary fuel cell evaluation of such structures are also presented. (Author)

A82-31876\*# Jet Propulsion Lab., California Inst. of Tech., Pasadena.

**THE ALKALI METAL THERMOELECTRIC CONVERTER /AMTEC/ - A NEW DIRECT ENERGY CONVERSION TECHNOLOGY FOR AEROSPACE POWER**

C. P. BANKSTON, T. COLE, R. JONES, and R. EWELL (California Institute of Technology, Jet Propulsion Laboratory, Pasadena, CA) American Institute of Aeronautics and Astronautics and American Society of Mechanical Engineers, Joint Thermophysics, Fluids, Plasma and Heat Transfer Conference, 3rd, St. Louis, MO, June 7-11, 1982, AIAA 10 p. refs

(Contract NAS7-100)

(AIAA PAPER 82-0862)

A thermally regenerative electrochemical device for the direct conversion of heat to electrical energy, the alkali metal thermoelectric converter (AMTEC), is characterized by potential efficiencies on the order of 15-40% and possesses no moving parts, making it a candidate for space power system applications. Device conversion efficiency is projected on the basis of experimental voltage vs current curves exhibiting power densities of 0.7 W/sq cm and measured electrode efficiencies of up to

40%. Preliminary radiative heat transfer measurements presented may be used in an investigation of methods for the reduction of AMTEC parasitic radiation losses. AMTEC assumes heat input and rejection temperatures of 900-1300 K and 400-800 K, respectively. The working fluid is liquid sodium, and the porous electrode employed is of molybdenum. O.C.

A82-31910#

**SIMULATION OF THE START-UP TRANSIENT RESPONSES OF THE UTSI COAL-FIRED MHD POWER GENERATING SYSTEM**

Y. F. LIAO, M. ISHIKAWA, H. J. SCHMIDT, and T. C. L. WU (Tennessee, University, Tullahoma, TN) American Institute of Aeronautics and Astronautics and American Society of Mechanical Engineers, Joint Thermophysics, Fluids, Plasma and Heat Transfer Conference, 3rd, St. Louis, MO, June 7-11, 1982, AIAA 12 p. refs

(Contract DE-AC02-79ET-10815)

(AIAA PAPER 82-0920)

A numerical procedure for solving the unsteady, two-dimensional, compressible Navier-Stokes equations has been extended for MHD flows by the inclusion of the appropriate Lorentz force and Joule heating terms in the governing equations. With appropriate initial and boundary conditions, the procedure can be used for the investigation of transient phenomena as well as the asymptotic steady-state characteristics of internal MHD flows. Results obtained for the simulation of starting processes in the UTSI (University of Tennessee Space Institute) coal-fired MHD flow train are presented and found to be in good agreement with experimental observations. (Author)

A82-31911#

**FAULT ANALYSIS OF MID-CHANNEL POWER TAKEOFF IN DCW MHD GENERATORS**

M. ISHIKAWA, Y. C. L. WU, and M. H. SCOTT (Tennessee, University, Tullahoma, TN) American Institute of Aeronautics and Astronautics and American Society of Mechanical Engineers, Joint Thermophysics, Fluids, Plasma and Heat Transfer Conference, 3rd, St. Louis, MO, June 7-11, 1982, AIAA 9 p. refs

(Contract DE-AC02-79ET-10815)

(AIAA PAPER 82-0922)

Analysis is presented of the effect of loading faults on the mid-channel power takeoff of a diagonal-conducting-wall MHD generator in special loading schemes. Two-dimensional calculations indicate that an open-circuit condition in the upstream load circuit results in a large current density at the power takeoff anode and drives a shorting current over the interframe insulators at the cathode side. A short-circuit condition in the upstream load circuit results in a large current density at the power takeoff cathode and a shorting current over the interframe insulators at the anode side. V.L.

A82-31912#

**INTERACTION BETWEEN MHD GENERATOR AND DC-AC POWER CONVERSION SYSTEM**

D. TANAKA (Niihama Technical College, Niihama, Ehime, Japan) American Institute of Aeronautics and Astronautics and American Society of Mechanical Engineers, Joint Thermophysics, Fluids, Plasma and Heat Transfer Conference, 3rd, St. Louis, MO, June 7-11, 1982, AIAA 8 p. refs

(AIAA PAPER 82-0923)

Transient characteristics of an MHD power generating system including a DC-AC inverter are analyzed using a time-dependent quasi-one-dimensional approximation. The generator model considered is Faraday type of U-25 class with heavy-oil and air combustion gas. It is found that a short-circuited fault of the inverter may become more serious than an open-circuited fault, resulting in significant gas velocity reduction. An open-circuited fault, if retained for more than 5-8 ms, can substantially increase the gas velocity at the upstream end of the fault region. A protection system composed of a fast-acting DC circuit-breaker and an emergency load resistance is proposed. The switching speed of the DC breaker must be about 500 microsec to stop a pressure

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increase, resulting, for example, from the short-circuiting of 20 electrode pairs, before it reaches 120% of the initial level. V.L.

### **A82-31947\*# Oklahoma State Univ., Stillwater. MODELING PARAMETER INFLUENCES ON MHD SWIRL COMBUSTION NOZZLE DESIGN**

D. G. LILLEY (Oklahoma State University, Stillwater, OK), A. K. GUPTA (MIT, Cambridge, MA), and A. A. BUSNAINA American Institute of Aeronautics and Astronautics and American Society of Mechanical Engineers, Joint Thermophysics, Fluids, Plasma and Heat Transfer Conference, 3rd, St. Louis, MO, June 7-11, 1982, AIAA 10 p. refs  
(Contract DE-QC01-79ET-15518; NAG3-74)  
(AIAA PAPER 82-0984)

Attention is given to a research project which has the goal to develop a two-stage slagging gasifier-combustor in the form of a high-intensity combustor, taking into account a suitable aerodynamic design of the second stage nozzle which will prevent the separation of the boundary layer as the flow turns from axial to radial direction. The specific objectives of the present investigation are to test the effect of various second-stage nozzle geometries, flow rates, swirl number, and distribution in the first and second stages upon the corresponding flowfield in the second stage. Special emphasis is given to the avoidance of boundary layer separation as the flow turns from axial to radial direction into the MHD disk generator. G.R.

### **A82-32331 SALINITY-GRADIENT VAPOR-PRESSURE POWER CONVERSION**

M. S. OLSSON (California, University, La Jolla, CA) Energy (UK), vol. 7, Mar. 1982, p. 237-246. Research supported by the University of California and Foundation for Ocean Research. refs

The interface between water bodies of different salinities represents a large unexploited source of energy. An energy conversion approach that does not require the use of membranes but uses the differences in vapor pressure between solutions is examined. The resource potential, source solutions, system components, and operating characteristics are evaluated and, where similar, compared to research and development on open-cycle OTEC (Ocean Thermal Energy Conversion). It is shown that salinity-gradient, vapor-pressure power generation is within reach of current technology. (Author)

### **A82-32372 EFFICIENCIES OF HEAT ENGINES AND FUEL CELLS - THE METHANOL FUEL CELL AS A COMPETITOR TO OTTO AND DIESEL ENGINES**

R. W. GLAZEBROOK (Shell Research, Ltd., Thornton Research Centre, Chester, England) Journal of Power Sources, vol. 7, Mar. 1982, p. 215-256. refs

As the real cost of fuel rises the efficiency of energy conversion devices will become of increasing importance. Efficiency is a variable factor depending inter alia on load factor. Whereas heat engines commonly yield optimum efficiencies at near to maximum power, fuel cells yield optimum efficiencies at zero power. Projections based on realistic developments suggest that fuel cells will operate overall with higher efficiencies than heat engines when load factors are below approximately 45%. Road transportation generally operates at load factors much lower than this and represents a suitable market for fuel cells. (Author)

### **A82-32566# LARGE AREA, HIGH SPEED DETECTORS FOR THE ULTRAVIOLET**

S. C. STOTLAR, E. J. MCLELLAN, and C. R. JONES (Los Alamos National Laboratory, Los Alamos, NM) In: Los Alamos Conference on Optics '81, 2nd, Los Alamos, NM, April 7-10, 1981, Proceedings. Bellingham, WA, SPIE - The International Society for Optical Engineering, 1981, p. 421-425. Research sponsored by the U.S. Department of Energy.

Pyroelectric detectors are a type of energy sensor which provides broadband spectral operation, six-decade linearity and

simplicity of application. It is shown that detectors of strontium barium niobate and lithium tantalate are the most useful in the family of pyroelectric materials for UV applications, with response times that range from below 100 picosec to 1 sec. The design of appropriate UV detectors requires characterization of a given pyroelectric substance's pulse damage threshold and the examination of surface preparation techniques. O.C.

### **A82-32760 THE PROBABILITY DISTRIBUTION OF WIND POWER FROM A DISPERSED ARRAY OF WIND TURBINE GENERATORS**

J. CARLIN (Commonwealth Scientific and Industrial Research Organization, Div. of Mathematics and Statistics, Canberra, Australia) and J. HASLETT (Trinity College, Dublin, Ireland) Journal of Applied Meteorology, vol. 21, Mar. 1982, p. 303-313. Research supported by the National Energy Research, Development and Demonstration Council of Australia. refs

A method is presented for estimating the probability distribution of wind power from a dispersed array of wind turbine sites where the correlation between wind speeds at distinct sites is less than unity. The distribution is obtained from a model for the joint probability distribution of wind speeds. This is able to incorporate arbitrary inter-site correlations. It is shown that this joint distribution reduces in the single site case to a wind speed distribution closely approximating the widely used Weibull; the multiple site power distribution is also shown to fit adequately to data on wind speeds from four sites in Western Australia. Results presented in graphical and tabular form for a range of representative cases show that a significant reduction in the variability of total wind power output may result from dispersion of aerogenerator sites; a quantitative guide to the magnitude of these effects is also provided. (Author)

### **A82-32772 WIND POWER AS AN ELECTRICAL ENERGY SOURCE IN ILLINOIS**

W. M. WENDLAND (Illinois State Water Survey, Dept. of Energy and Natural Resources, Champaign, IL) Journal of Applied Meteorology, vol. 21, Mar. 1982, p. 423-428.

A preliminary estimate of the total wind power available in Illinois was made using available historical data, and projections of cost savings due to the presence of wind-generated electricity were attempted. Wind data at 10 m height were considered from nine different sites in the state, with three years data nominally being included. Wind-speed frequency histograms were developed for day and night periods, using a power law function to extrapolate the 10 m readings to 20 m. Wind speeds over the whole state were found to average over 8 mph, the cut-in point for most wind turbines, for from 40-63% of the time. A maximum of 75% run-time was determined for daylight hours in April-May. A reference 1.8 kW windpowered generator was used in annual demand projections for a reference one family home, using the frequency histograms. The small generator was projected to fulfill from 25-53% of the annual load, and, based on various cost assumptions, exhibited paybacks taking from 14-27 yr. M.S.K.

### **A82-33397 OPTIMIZATION OF THE OPERATION OF A WIND POWER PLANT [OPTIMIZATSIYA REZHIMA RABOTY VETROSILOVOI USTANOVKI]**

A. D. MUZYCHENKO and V. V. PSHENICHNYI (Akademiia Nauk Ukrainskoi SSR, Institut Elektrodinamiki, Kiev, Ukrainian SSR) In: Methods and technical tools for current stabilization (Metody i tekhnicheskie sredstva stabilizatsii toka). Kiev, Izdatel'stvo Naukova Dumka, 1980, p. 119-125. In Russian. refs

The paper proposes an optimal design scheme for a wind powerplant, whereby, in the case of variable wind velocity, maximum power extraction corresponding to this variable velocity is achieved. The optimal design must include a voltage-source to current-source converter between the aerogenerator and the buffer battery, and the control of the generator must provide for nonlinear feedback with respect to the rotation velocity of the aerogenerator shaft. B.J.

**A82-33701**

**BIENNIAL WIND ENERGY CONFERENCE AND WORKSHOP, 5TH, WASHINGTON, DC, OCTOBER 5-7, 1981, PROCEEDINGS**, ASME, Transactions, Journal of Solar Energy Engineering, vol. 104, May 1982, 74 p.

The results of studies funded by the Federal government to advance the state of the art of wind energy conversion systems (WECS) construction, operation, applications, and financial viability are presented. The economics of WECS were considered in terms of applicable tax laws, computer simulations of net value of WECS to utilities, and the installation of Mod-2 2.5 MW and WTS-4 4MW wind turbines near Medicine Bow, WY to test the operation of two different large WECS on the same utility grid. Potential problems of increasing penetration of WECS-produced electricity on a utility grid were explored and remedies suggested. The structural dynamics of wind turbines were analyzed, along with means to predict potential noise pollution from large WECS, and to make blade fatigue life assessments. Finally, Darrieus rotor aerodynamics were investigated, as were dynamic stall in small WECS and lightning protection for wind turbines and components.

M.S.K.

**A82-33702#**

**STRATEGIES FOR MINIMIZING OPERATIONAL IMPACTS OF LARGE WIND TURBINE ARRAYS ON AUTOMATIC GENERATION CONTROL SYSTEMS**

T. W. REDDOCH, P. R. BARNES (Oak Ridge National Laboratory, Oak Ridge, TN), J. S. LAWLER (Tennessee, University, Knoxville, TN), and J. C. SKROSKI (Atlantic City Electric Co., Atlantic City, NJ) (Biennial Wind Energy Conference and Workshop, 5th, Washington, DC, Oct. 5-7, 1981.) ASME, Transactions, Journal of Solar Energy Engineering, vol. 104, May 1982, p. 65-69. refs (Contract W-7405-ENG-26)

A primary application of wind electric generation is expected to be large clusters or arrays of MW-size wind turbines connected to the utility transmission network. Array output power variations due to the uncontrolled nature of the wind resource can cause undesirable dynamic impacts on the utility system, such as excessive frequency and/or tie-line power flow deviations. As a consequence, spinning reserve, unloadable generation, and load following requirements and their associated economic penalties tend to increase as wind electric generation is added to the system. However, if array power variations are limited and/or anticipated, the associated operation and economic penalties can be significantly reduced. In this paper, a number of operational concepts are considered which have the potential to enhance the effectiveness of wind turbine arrays in the utility system.

(Author)

**A82-33703#**

**WIND SYSTEM VALUE ANALYSIS FOR ELECTRIC UTILITIES - A COMPARISON OF FOUR METHODS**

J. HARPER, D. PERCIVAL, T. FLAIM (Solar Energy Research Institute, Golden, CO), and R. L. SULLIVAN (Florida, University, Gainesville, FL) (Biennial Wind Energy Conference and Workshop, 5th, Washington, DC, Oct. 5-7, 1981.) ASME, Transactions, Journal of Solar Energy Engineering, vol. 104, May 1982, p. 70-76. (Contract EG-77-C-01-4042)

A comparison and suggestions for improvements in the SERI-H, SERI Weibull, AERO, and JBF value models for estimation of the economic worth of wind energy conversion systems (WECS) to utilities are made. The simulations comprise projections for operations with and without WECS, fuel, operation, and maintenance costs, base load and generating capacity, reliability, estimated WECS performance, wind resource, fuel escalation rates, and scenarios with pumped hydro storage. The Weibull curve was found to be good in the SERI-H model only for considering winds above cut-in. Reasonable agreement was found at the 5% peak load penetration level for all models. Installing 635 MW of WECS was determined to replace from 126-177.9 MW of conventional utility generator capacity. The breakeven value for Mod 2 installation was determined at \$1620/kW for use in southern California and \$1850-2470/kW in Michigan.

M.S.K.

**A82-33704#**

**MEDICINE BOW WIND PROJECT**

L. L. NELSON (U.S. Bureau of Reclamation, Denver, CO) (Biennial Wind Energy Conference and Workshop, 5th, Washington, DC, Oct. 5-7, 1981.) ASME, Transactions, Journal of Solar Energy Engineering, vol. 104, May 1982, p. 77-83.

The Bureau of Reclamation (Bureau) conducted studies for a wind turbine field of 100 MW at a site near Medicine Bow, WY, one of the windiest areas in the United States. The wind turbine system would be electrically interconnected to the existing Federal power grid through the substation at Medicine Bow. Power output from the wind turbines would thus be integrated with the existing hydroelectric system, which serves as the energy storage system. An analysis based on 'willingness to pay' was developed. Based on information from the Department of Energy's Western Area Power Administration (Western), it was assumed that 90 mills per kWh would represent the 'willingness to pay' for onpeak power, and 45 mills per kWh for offpeak power. The report concludes that a 100-MW wind field at Medicine Bow has economic and financial feasibility. The Bureau's construction of the Medicine Bow wind field could demonstrate to the industry the feasibility of wind energy.

(Author)

**A82-33750**

**THE TM 333, A TRUMP CARD FOR TURBOMECA [LE TM 333, ATOUT MAJEUR DE TURBOMECA]**

J. MORISSET Air et Cosmos, vol. 20, May 8, 1982, p. 13, 15-17. In French.

The new dual turbine, digital control TM 333 helicopter motor is described as having benefitted from a ten year program in basic aerodynamics, metallurgy, and electronics research. High compression, high expansions in reverse flow digitally controlled engines are coupled with improvements in the gear reductions and joints. The helicopter achieves program goals set in July 1979 of low operating cost, efficient fuel consumption over a broad power range, modular maintenance, fewer parts and lower purchase price, and low specific weight. The power plant furnishes a take-off impulse of 625 kW with a continuous output of 560 kW, with a fuel consumption of 318-330 gr/kWh. Specific performance features are listed and comparisons are made with turbines of other manufacturers.

M.S.K.

**A82-33996**

**THE DEVELOPMENT OF MHD ENERGY CONVERSION METHODS IN THE USSR**

V. A. KIRILLIN and A. E. SHEINDLIN (Akademiia Nauk SSSR, Institut Vysokikh Temperatur, Moscow, USSR) Indian Academy of Sciences, Proceedings, Section C: Engineering Sciences, vol. 4, Dec. 1981, p. 405-417. refs

It is noted that the development of magnetohydrodynamic (MHD) power conversion systems has evolved to the point where it is possible to commercially introduce MHD power plants into industry. Even with the present level of technology, the sharp increase in thermal efficiency of these plants by as much as 50-60% results in fuel economies of 20-35% and in reductions in generation costs of 6-7%. A description is given of an MHD power plant and its various aggregates. Also given are a review of the state of the art of MHD technology and an outline of the Soviet program for its commercial exploitation. The design of MHD electrical power plants, the interrelation between various aggregates, and the problems arising from nonstandard equipment are discussed.

C.R.

**A82-34488**

**SAIL-TYPE WIND-TURBINES - A REVIEW AND ANNOTATED BIBLIOGRAPHY**

P. D. FLEMING and S. D. PROBERT (Cranfield Institute of Technology, Cranfield, Beds., England) Applied Energy, vol. 10, Apr. 1982, p. 273-286. Research supported by the Science Research Council of England.

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**A82-34521**

**OPTIMIZATION OF THE REGION OF INVERSE CONVERSION IN A CYCLOTRON MICROWAVE CONVERTER [OB OPTIMIZATSII OBLASTI OBRATNOGO PREOBRAZOVANIYA TSIKLOTRONNOGO SVCH-KONVERTORA]**

B. F. BUNIMOVICH, K. V. GRECHUSHKIN, V. V. GURZO, V. N. PROKUSHKIN, and V. S. STALMAKHOV Radiotekhnika i Elektronika, vol. 27, May 1982, p. 1004-1008. In Russian. refs

Nonrelativistic equations of electron motion in varying magnetic and electric fields in a thin-sphere segment are presented. An analysis is given of the geometry-optimization of a collector with the aim of increasing the efficiency of inverse conversion in microwave converters (such as those planned for systems involving microwave power transmission from satellite solar power stations to earth). It is shown that high efficiency of the inverse-conversion region can be achieved at lengths of magnetic-field variation that are much greater than the cyclotron wavelength. This approach is particularly applicable to converters with plane-symmetric magnetic-field reversal. B.J.

**A82-34522**

**NUMERICAL SIMULATION OF RECOVERY PROCESSES IN A CYCLOTRON CONVERTER [CHISLENNOE MODELIROVANIE PROTSESSOV REKUPERATSII V TSIKLOTRONNOM PREOBRAZOVATELE]**

I. M. BLEIVAS, V. A. VANKE, L. M. RYBNIKOVA, and V. L. SAVVIN Radiotekhnika i Elektronika, vol. 27, May 1982, p. 1009-1013. In Russian. refs

An axisymmetric electron-beam model is used in a numerical analysis of recovery processes in a cyclotron converter of microwave oscillations into direct current (such as that planned for satellite solar power systems). Secondary electrons emitted from the surfaces of the collector electrodes are taken into account. The spatial distribution of electric and magnetic fields in the collector cavity which provides for a recovery of 94 percent of the energy of the longitudinal motion of the electron beam is determined. B.J.

**A82-34523**

**GROUND-BASED RECEIVING-CONVERTING COMPLEX FOR SATELLITE SOLAR POWER SYSTEMS [O NAZEMNOM PRIEMNO-PREOBRAZUIUSHCHEM KOMPLEKSE SOLNECHNYKH KOSMICHESKIKH ENERGOSISTEM]**

V. A. VANKE, V. M. LOPUKHIN, V. K. ROSNOVSKII, V. L. SAVVIN, and K. I. SIGORIN Radiotekhnika i Elektronika, vol. 27, May 1982, p. 1014-1019. In Russian. refs

The paper examines the prospects of using Schottky-barrier diodes and cyclotron energy converters in ground-based receiving-converting complexes in satellite solar power systems. Rectenna systems based on Schottky-barrier diodes would provide for efficient microwave beam transmission; and load-stable, high-efficiency, high-voltage cyclotron converters would be used to transform microwave energy into direct current. B.J.

**A82-34700**

**AIR COOLING OF GAS TURBINE BLADES**

O. N. FAVORSKII and S. Z. KOPELEV (Teploenergetika, vol. 28, Aug. 1981, p. 7-11.) Thermal Engineering, vol. 28, Aug. 1981, p. 435-438. Translation. refs

During the last 20 years, the gas temperature at the inlet of aircraft gas turbines has been raised by 450 K to a temperature of 1650 K. The achievement of the current high operational temperatures, which have led to a considerable enhancement in engine efficiency, has been largely made possible by the development of suitable approaches for cooling the gas turbine blades. The various factors involved in designing an effective cooling procedure are considered, taking into account the necessity that the involved flow processes must not result in a lowering of engine efficiency, and, in connection with large temperature gradients or the introduction of stress-raising design features, must not unduly reduce the operational life of the engine. Attention is given to the internal convective and the convection-film air cooling of blades, the promotion of flow turbulence by means of internal

baffles, the hydraulic resistance of internal cooling channels, and merits and drawbacks of perforations. G.R.

**A82-34951**

**SWITCHING NETWORKS FOR REALISATION OF VARIABLE DC TRANSFORMERS COUPLED TO RECTANGULAR ARRAYS**

S. SINGER (Tel Aviv University, Tel Aviv, Israel) IEE Proceedings, Part G - Electronic Circuits and Systems, vol. 129, pt. G, no. 3, June 1982, p. 69-75.

The process by which the structure of a rectangular array with variable interconnections is changed can be described by an equivalent circuit in which a nonvariable array is coupled to the load by means of a variable 'DC transformer' (DCT). This kind of array can be applied in cases in which it is necessary to match the source and the load, when either one or both are composed of identical elements which can be organized into a rectangular array structure. Applications of the considered approach are related to maximum power trackers of photovoltaic systems, voltage multipliers, electric cars, and a special type of DC/AC converter. A description is presented of the realization of a variable array by means of switching networks using a minimum number of switching elements. G.R.

**A82-35038\*#** General Motors Corp., Indianapolis, Ind.

**AGT 100 AUTOMOTIVE GAS TURBINE SYSTEM DEVELOPMENT**

H. E. G. HELMS (General Motors Corp., Detroit Diesel Allison Div., Indianapolis, IN) AIAA, SAE, and ASME, Joint Propulsion Conference, 18th, Cleveland, OH, June 21-23, 1982, AIAA 11 p. Research sponsored by the U.S. Department of Energy (Contract DEN3-168) (AIAA PAPER 82-1165)

General Motors is developing an automotive gas turbine system that can be an alternate powerplant for future automobiles. Work sponsored by DOE and administered by NASA Lewis Research Center is emphasizing small component aerodynamics and high-temperature structural ceramics. Reliability requirements of the AGT 100 turbine system include chemical and structural ceramic component stability in the gas turbine environment. The power train system, its configuration and schedule are presented, and its performance tested. The aerodynamic component development is reviewed with discussions on the compressor, turbine, regenerator, interturbine duct and scroll, and combustor. Ceramic component development is also reviewed, and production cost and required capital investment are taken into consideration. D.L.G.

**A82-35039\*#** Garrett Turbine Engine Co., Phoenix, Ariz.

**AGT101 AUTOMOTIVE GAS TURBINE SYSTEM DEVELOPMENT**

R. A. RACKLEY and J. R. KIDWELL (Garrett Turbine Engine Co., Phoenix, AZ) AIAA, SAE, and ASME, Joint Propulsion Conference, 18th, Cleveland, OH, June 21-23, 1982, AIAA 8 p. Research sponsored by the U.S. Department of Energy (Contract DEN3-167) (AIAA PAPER 82-1166)

The AGT101 automotive gas turbine system consisting of a 74.6 kw regenerated single-shaft gas turbine engine, is presented. The development and testing of the system is reviewed, and results for aerothermodynamic components indicate that compressor and turbine performance levels are within one percent of projected levels. Ceramic turbine rotor development is encouraging with successful cold spin testing of simulated rotors to speeds over 12,043 rad/sec. Spin test results demonstrate that ceramic materials having the required strength levels can be fabricated by net shape techniques to the thick hub cross section, which verifies the feasibility of the single-stage radial rotor in single-shaft engines. D.L.G.

**A82-35040\*** General Motors Corp., Indianapolis, Ind.

**CERAMIC APPLICATIONS IN TURBINE ENGINES**

J. A. BYRD and H. E. HELMS (General Motors Corp., Detroit Diesel Allison Div., Indianapolis, IN) AIAA, SAE, and ASME, Joint Propulsion Conference, 18th, Cleveland, OH, June 21-23, 1982, AIAA 12 p. Research supported by the U.S. Department of Energy and NASA.  
(AIAA PAPER 82-1168)

In the past the potential of vehicular gas engines could not be realized because component materials served to limit the turbine operating temperature, thereby restricting fuel economy and initial cost. It was, therefore, not possible for the vehicular gas turbine to compete with more conventional engines. The emergence of low-cost, high-temperature ceramic components has the potential to reverse this situation. For example, the Allison GT404 engine, operating with ceramic components at turbine inlet temperatures up to 2350 F to 2500 F, has the potential of a fuel economy which is better than that of current Diesel engines. The Allison AGT100 engine operating with ceramic components offers the possibility of a 30% improvement in fuel economy over 1985 spark ignition engines. The materials considered for an employment in the ceramic components include silicon carbide, silicon nitride, aluminum silicate, and lithium aluminum silicate. G.R.

**A82-35061\*** General Motors Corp., Indianapolis, Ind.

**AGT100 TURBOMACHINERY**

D. L. TIPTON and T. F. MCKAIN (General Motors Corp., Detroit Diesel Allison Div., Indianapolis, IN) AIAA, SAE, and ASME, Joint Propulsion Conference, 18th, Cleveland, OH, June 21-23, 1982, AIAA 11 p. Research supported by the U.S. Department of Energy  
(Contract DEN3-168)  
(AIAA PAPER 82-1207)

High-performance turbomachinery components have been designed and tested for the AGT100 automotive engine. The required wide range of operation coupled with the small component size, compact packaging, and low cost of production provide significant aerodynamic challenges. Aerodynamic design and development testing of the centrifugal compressor and two radial turbines are described. The compressor achieved design flow, pressure ratio, and surge margin on the initial build. Variable inlet guide vanes have proven effective in modulating flow capacity and in improving part-speed efficiency. With optimum use of the variable inlet guide vanes, the initial efficiency goals have been demonstrated in the critical idle-to-70% gasifier speed range. The gasifier turbine exceeded initial performance goals and demonstrated good performance over a wide range. The radial power turbine achieved 'developed' efficiency goals on the first build. (Author)

**A82-35062\*** General Motors Corp., Indianapolis, Ind.

**COMBUSTOR DEVELOPMENT FOR AUTOMOTIVE GAS TURBINES**

P. T. ROSS, J. R. WILLIAMS (General Motors Corp., Detroit Diesel Allison Div., Indianapolis, IN), and D. N. ANDERSON (NASA, Lewis Research Center, Cleveland, OH) AIAA, SAE, and ASME, Joint Propulsion Conference, 18th, Cleveland, OH, June 21-23, 1982, AIAA 9 p. Research supported by the U.S. Department of Energy refs  
(Contract DEN3-168)  
(AIAA PAPER 82-1208)

The development of a combustion system for the AGT 100 automotive gas turbine engine is described. A maximum turbine inlet temperature of 1288 C is reached during the regenerative cycle, and air up to 1024 C is supplied to the combustor inlet. A premix/prevaporization ceramic combustor employing variable geometry to control burning zone temperature was developed and tested. Tests on both metal and ceramic combustors showed that emissions were a function of burner inlet temperature (BIT). At 999 C BIT, NO(x) emissions were two orders of magnitude below program goals, and at the same temperature but at a different variable geometry position, the CO was 30 times below program goal. Tests to evaluate the durability of the ceramic materials

showed no failures during steady-state operation; however, some cracks developed in the dome during extended transient operation. C.D.

**A82-35229**

**INDUCTIVE POWER TRANSFER FOR PROPULSION**

C. E. WALTER (California, University, Livermore, CA) Journal of Advanced Transportation, vol. 16, Spring 1982, p. 73-86. refs  
(Contract W-7405-ENG-48)

Current research and development work on inductive power transfer to moving road vehicles at the Lawrence Livermore National Laboratory is described. The Roadway Powered Electric Vehicle (RPEV) project involves the use of an air gap transformer which inductively couples the primary power source in the roadway to the secondary, which is suspended beneath the vehicle. Incorporating electrical battery storage for operation independent of the primary power source, this scheme could provide highway transportation with no visual or audible presence, no noxious fumes, and without dedicated use constraints such as those of railways. Attention is given to the design details of roadway power components and automobile power system configuration, and the impact on electrical utility generating capacity is assessed. An appeal is made for a continuation of substantial state and federal funding of RPEV research, on the grounds of the severity of national dependence on imported petroleum. O.C.

**A82-35321\*** Garrett Turbine Engine Co., Phoenix, Ariz.

**THE AGT 101 ADVANCED AUTOMOTIVE GAS TURBINE**

R. A. RACKLEY and J. R. KIDWELL (Garrett Turbine Engine Co., Phoenix, AZ) American Society of Mechanical Engineers, International Gas Turbine Conference and Exhibit, 27th, London, England, Apr. 18-22, 1982, 9 p. Research supported by the U.S. Department of Energy  
(Contract DEN3-167)  
(ASME PAPER 82-GT-72) MEMBERS, \$2.00; NONMEMBERS, \$4.00

A development program is described whose goal is the accumulation of the technology base needed by the U.S. automotive industry for the production of automotive gas turbine powertrains. Such gas turbine designs must exhibit reduced fuel consumption, a multi-fuel capability, and low exhaust emissions. The AGT101 powertrain described is a 74.6 kW, regenerated single-shaft gas turbine, operating at a maximum inlet temperature of 1644 K and coupled to a split differential gearbox and automatic overdrive transmission. The engine's single stage centrifugal compressor and single stage radial inflow turbine are mounted on a common shaft, and will operate at a maximum rotor speed of 100,000 rpm. All high temperature components, including the turbine rotor, are ceramic. O.C.

**A82-35349#**

**THE AGT 100 AUTOMOTIVE GAS TURBINE STATUS AND ASSESSMENT**

H. E. BARRETT (General Motors Corp., Detroit Diesel Allison Div., Indianapolis, IN) American Society of Mechanical Engineers, International Gas Turbine Conference and Exhibit, 27th, London, England, Apr. 18-22, 1982, 11 p.  
(ASME PAPER 82-GT-118) MEMBERS, \$2.00; NONMEMBERS, \$4.00

The progress of the key elements of the AGT 100, an advanced gas turbine power train system being developed at General Motors under NASA contract, is discussed. The project goals, including the design objectives, are stated, and the two-phase schedule is described. The AGT 100 basic engine data and the weight of its ceramic and strategic materials are shown. The engine performance at maximum and part power and at idle are indicated for centrifugal compressor, radial gas turbine, radial power turbine, and regenerator. Each of these parts is discussed in detail, as are the interturbine duct and scroll and the combustor. The ceramic component development is discussed with special attention given to the combustors and turbine rotor. Finally, cost factors are examined and future prospects are assessed. C.D.

### A82-35422#

#### THE CONTROL OF ENGINE VIBRATION USING SQUEEZE-FILM DAMPERS

R. HOLMES (Sussex, University, Brighton, England) American Society of Mechanical Engineers, International Gas Turbine Conference and Exhibit, 27th, London, England, Apr. 18-22, 1982, 8 p. Research supported by the Science Research Council and Ministry of Defence. refs  
(ASME PAPER 82-GT-241) MEMBERS, \$2.00; NONMEMBERS, \$4.00

This paper describes the following roles of a squeeze-film damper when used in gas turbine applications as a means of reducing vibration and transmitted force due to unbalance: (1) as an element in parallel with a soft spring in a vibration isolator, and (2) as an element in series with the stiffness of the engine pedestal. The effects of cavitation on performance are elucidated and the dangers of jump phenomena and subsynchronous response are discussed. Experimental work is described in which both roles of the squeeze-film damper are investigated and the results are compared with theoretical predictions. (Author)

### A82-35432#

#### CERAMIC COMPONENTS FOR AUTOMOTIVE AND HEAVY DUTY TURBINE ENGINES - CATE AND AGT 100

H. E. HELMS and J. A. BYRD (General Motors Corp., Detroit Diesel Allison Div., Indianapolis, IN) American Society of Mechanical Engineers, International Gas Turbine Conference and Exhibit, 27th, London, England, Apr. 18-22, 1982, 10 p. refs  
(ASME PAPER 82-GT-253) MEMBERS, \$2.00; NONMEMBERS, \$4.00

Detroit Diesel Allison is actively applying advanced ceramic materials to components in gas turbine engines. Silicon carbide, silicon nitride, aluminum silicate, lithium aluminum silicate, and mullite are materials being used in various components in both the DDA GT 404-4 and AGT 100 engines. Approximately 9400 hr of ceramic component operating time in the GT 404 engine has been accumulated, and design, component processing, proof testing, and engine testing experience have begun to show the applicability of ceramic materials in production engines. Material variability, processing procedures, strength characterization, and nondestructive evaluations are emerging as critical but controllable factors. Ceramic components offer the potential of significant fuel consumption improvements in gas turbine engines for vehicles and other applications. (Author)

### A82-35440#

#### PHYSICAL VAPOR DEPOSITION OF CERAMIC COATINGS FOR GAS TURBINE ENGINE COMPONENTS

R. E. DEMARAY (Airco Temescal, Metallurgical Products Div., Berkeley, CA), J. W. FAIRBANKS (U.S. Department of Energy, Combustion Heat Systems Div., Washington, DC), and D. H. BOONE (California, University, Berkeley, CA) American Society of Mechanical Engineers, International Gas Turbine Conference and Exhibit, 27th, London, England, Apr. 18-22, 1982, 8 p. refs  
(ASME PAPER 82-GT-264) MEMBERS, \$2.00; NONMEMBERS, \$4.00

Significant improvements are reported in turbine engine ceramic thermal barrier coatings, with respect to both hot corrosion resistance and ceramic thermal cycle fatigue. Such coatings in turbine engine hot section airfoils improve engine performance, durability and fuel economy. After an historical account of ceramic coating development, attention is given to the recent development of mechanically segmented, or microcolumnar structure, coatings produced by the physical vapor deposition (PVD) of ceramic materials on metallic turbine airfoil components. PVD coatings accommodate thermal cycle stresses due to thermal expansion coefficient differences between the coating and its metallic substrate. Hot corrosion, erosion, and thermal fatigue protection properties are considered, and it is concluded that hot corrosion protection is provided for a wide range of fuels which includes the emerging alternate, coal-derived formulations. O.C.

### A82-35450\*# General Electric Co., Cincinnati, Ohio.

#### PROGRESS IN THE DEVELOPMENT OF ENERGY EFFICIENT ENGINE COMPONENTS

R. W. BUCY (General Electric Co., Cincinnati, OH) American Society of Mechanical Engineers, International Gas Turbine Conference and Exhibit, 27th, London, England, Apr. 18-22, 1982, 7 p. refs

(Contract NAS3-20643)

(ASME PAPER 82-GT-275) MEMBERS, \$2.00; NONMEMBERS, \$4.00

Component test results are presented for the NASA Energy Efficient Engine program, whose design goals relative to the CF6-50C reference engine include a 12% reduction in specific fuel consumption, 5% reduction in direct operating costs, and 50% reduction in specific fuel consumption deterioration rate over the course of commercial service. Emphasis is placed on the engine's high pressure compressor, which has a design pressure ratio of 23:1, and has completed a series of component tests whose resulting configuration is expected to meet all major objectives of the program. Descriptions are given of the core engine and integrated core/low spool tests, and system test benefits are discussed. Attention is given to the design features of the engine's double annular combustor, high and low pressure air turbines, and scale model exhaust mixer. O.C.

### A82-35481#

#### THE FEASIBILITY OF ELECTRIC POWER GENERATION BY THE WIND ON THE UNIVERSITY OF NEW ORLEANS CAMPUS

L. B. HILBERT, JR. (Exxon Corp., Houston, TX) and W. S. JANNA (New Orleans, University, New Orleans, LA) American Society of Mechanical Engineers, Energy-Sources Technology Conference and Exhibition, New Orleans, LA, Mar. 7-10, 1982, 8 p. refs  
(ASME PAPER 82-PET-1) MEMBERS, \$2.00; NONMEMBERS, \$4.00

### A82-35482#

#### THE SOUTHERN CALIFORNIA EDISON WIND TURBINE GENERATOR TEST PROGRAM

M. C. WEHREY and R. J. YINGER (Southern California Edison Co., Rosemead, CA) American Society of Mechanical Engineers, Energy-Sources Technology Conference and Exhibition, New Orleans, LA, Mar. 7-10, 1982, 6 p.  
(ASME PAPER 82-PET-2) MEMBERS, \$2.00; NONMEMBERS, \$4.00

This paper deals with the second area of Edison's wind energy R&D program: the demonstration of various WTG designs to provide, over a period of two to three years, the data needed to support the planning, installation and operation of WTGs on a commercial scale. The overall scope of the program is to document the performance of the WTGs being tested, to assess the operation and maintenance requirements of future WTGs, to train Edison personnel as WTG operators, and to evaluate the impact of WTGs on the Edison electrical system. The company is currently assessing horizontal-axis and vertical-axis WTGs. The results from the test program will provide information about specific performance characteristics and, at the same time, give Edison general operating experience with wind turbines. From the program Edison will be better able to properly judge the role that wind turbines can play in meeting future electrical generation needs. (Author)

### A82-35483#

#### SMALL WIND ENERGY CONVERSION SYSTEMS, APPLICATION AND PERFORMANCE

J. H. NORTON, JR. (North Wind Power Co., Inc., Moretown, VT) American Society of Mechanical Engineers, Energy-Sources Technology Conference and Exhibition, New Orleans, LA, Mar. 7-10, 1982, 6 p.  
(ASME PAPER 82-PET-3) MEMBERS, \$2.00; NONMEMBERS, \$4.00

This paper examines the two basic applications of SWECS - remote and utility interface - in the context of the products of the North Wind Power Company. First, the discussion of remote power briefly reviews the history of this type of application, describes

the specifications of the HR2 high reliability 2kW wind system, and examines in detail two commercial applications in the petroleum industry - their operation, environment and performance. Second, the discussion of utility interface briefly reviews the history of the L16 line interface 6kW wind system, and discusses its potential application in small commercial windfarms, remote community power systems and dispersed industrial, residential and agricultural applications. Finally, a perspective on the future of small wind energy technology is given. (Author)

**A82-35484#****WISCONSIN POWER AND LIGHT COMPANY'S WIND ENERGY RESEARCH AND DEMONSTRATION PROGRAM**

C. C. DEWINKEL (Wisconsin Power and Light Co., Madison, WI) American Society of Mechanical Engineers, Energy-Sources Technology Conference and Exhibition, New Orleans, LA, Mar. 7-10, 1982, 3 p.

(ASME PAPER 82-PET-4) MEMBERS, \$2.00; NONMEMBERS, \$4.00

**A82-35486#****DESIGN, PERFORMANCE AND ECONOMICS OF THE DAF INDAL 50 KW AND 375 KW VERTICAL AXIS WIND TURBINE**

L. A. SCHIENBEIN and D. J. MALCOLM (DAF Indal, Ltd., Mississauga, Ontario, Canada) American Society of Mechanical Engineers, Energy-Sources Technology Conference and Exhibition, New Orleans, LA, Mar. 7-10, 1982, 10 p. Department of Supply and Services refs

(Contract DSS-17SR-3115-0-4605)

(ASME PAPER 82-PET-6) MEMBERS, \$2.00; NONMEMBERS, \$4.00

A review of the development and performance of the DAF Indal 50 kW vertical axis Darrieus wind turbines shows that a high level of technical development and reliability has been achieved. Features of the drive train, braking and control systems are discussed and performance details are presented. A description is given of a wind-diesel hybrid presently being tested. Details are also presented of a 375 kW VAWT planned for production in late 1982. A discussion of the economics of both the 50 kW and 375 kW VAWTs is included, showing the effects of charge rate, installed cost, operating cost, performance and efficiency. The energy outputs are translated into diesel fuel cost savings for remote communities. (Author)

**A82-35487#****PROCEDURES FOR MODELING WIND TURBINE PERFORMANCE FROM SITE WIND DATA**

W. T. PENNELL and A. H. MILLER (Battelle Pacific Northwest Laboratories, Richland, WA) American Society of Mechanical Engineers, Energy-Sources Technology Conference and Exhibition, New Orleans, LA, Mar. 7-10, 1982, 10 p. Research sponsored by the Electric Power Research Institute refs

(Contract DE-AC06-76RL-01830)

(ASME PAPER 82-PET-7) MEMBERS, \$2.00; NONMEMBERS, \$4.00

A key problem in wind turbine siting is estimating how a given wind turbine will perform at a given site. Solving this problem requires a model for converting wind information from a site into accurate simulations of how a wind turbine installed at that site would have performed. This paper reviews current procedures for modeling wind turbine energy production and discusses the strengths and weaknesses of each procedure. Wind turbine performance simulations are compared at typical wind turbine sites. Comparisons of these simulations, as well as comparisons with existing data from actual wind turbine installations, suggest that accurate estimates of energy production for large wind turbine generators require simulation of the wind turbine's start-up, shutdown and, for the case of horizontal axis machines, yawing behavior. (Author)

**A82-35489#****THE DEVELOPMENT OF A 10 METER WIND TURBINE GENERATOR**

H. MEYER (Windworks, Inc., Mukwonago, WI) American Society of Mechanical Engineers, Energy-Sources Technology Conference and Exhibition, New Orleans, LA, Mar. 7-10, 1982, 5 p. Research supported by the U.S. Department of Energy.

(ASME PAPER 82-PET-10) MEMBERS, \$2.00; NONMEMBERS, \$4.00

An 8 kW, 10 m-diameter horizontal axis wind system whose prototype has been recently tested is described. The wind turbine is suitable for use in dispersed, interconnected applications. After prototype development, the design was refined and re-engineered for volume production. Power is generated by means of a direct-drive, permanent magnet alternator which operates over a variable speed range. This feature allows fixed turbine blade pitch operation up to rated wind speed, while maintaining optimum aerodynamic characteristics. Attention is given to the helicopter-like flapping rotor design, generator configuration, and tower erection method. O.C.

**A82-36076****INTERNATIONAL SYMPOSIUM ON WIND ENERGY SYSTEMS, 3RD, DANMARKS TEKNISKE HOJSKOLE, LYNGBY, DENMARK, AUGUST 26-29, 1980, PROCEEDINGS**

H. S. STEPHENS, (ED.) and C. A. STAPLETON (British Hydromechanics Research Association, Cranfield, Beds., England) Symposium sponsored by the British Hydromechanics Research Association. Cranfield, Beds., England, BHRA Fluid Engineering, 1980. 633 p \$66.25

The design, fabrication, materials, and numerical modeling of large and small wind turbines, wind energy programs in various countries, and methods of measuring the available wind resource are discussed. Attention is given to the DOE/NASA, SERI, and U.K. wind turbine development and testing programs, as well as to blade construction for large WECS. Siting considerations are examined in terms of surveys performed in Hawaii, California, and New Hampshire. The choice of generator type is investigated, as are structural design criteria for large WECS, drive train assemblies, measurements of WECS output, and the performance of Danish, German, and Swedish experimental machines. The aerodynamic modeling of vertical axis wind turbines, the performance of wind turbine arrays, and remote applications of wind turbine technology are detailed. Finally, methods of integrating wind-derived electricity with the grid are explored. M.S.K.

**A82-36077****ASSESSMENT OF OFFSHORE SITING OF WIND TURBINE GENERATORS**

D. LINDLEY, P. B. SIMPSON (Taywood Engineering, Ltd., Southall, Middx., England), U. HASSAN (ERA Technology, Ltd., Leatherhead, Surrey, England), and D. MILBORROW (Central Electricity Generating Board, Central Electricity Research Laboratories, Leatherhead, Surrey, England) In: International Symposium on Wind Energy Systems, 3rd, Lyngby, Denmark, August 26-29, 1980, Proceedings. Cranfield, Beds., England, BHRA Fluid Engineering, 1980, p. 17-42. refs

A technical and economic assessment has been made of the generation of electricity using wind turbine generators located in shallow waters off the coast of the United Kingdom. This assessment entailed studies of siting criteria, meteorology, sea surface conditions, engineering geology, construction materials, support structures, marination of complete WTG installations, effect of cluster configuration on performance, electrical transmission and control, availability and environmental issues. On the basis of these studies, an analysis has been made to determine economic and performance trends of clusters of up to 200 machines of a maximum of 10 MW individual generating capacity. Generating costs based on central values in the ranges of the design parameters are found to exceed predicted economic value in the year 2000 by a factor of about 3, whilst with large diameter

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turbines and average wind speeds exceeding the central value this factor is reduced to about 2. (Author)

### A82-36078

#### **WIND POWER GENERATION FOR NATIONAL AND REGIONAL GRID SYSTEMS DESIGN PROPOSALS FOR GENERATION AND TRANSMISSION**

R. FREER In: International Symposium on Wind Energy Systems, 3rd, Lyngby, Denmark, August 26-29, 1980, Proceedings. Cranfield, Beds., England, BHRA Fluid Engineering, 1980, p. 43-60. refs

Design features of large and medium WECS, the utility interconnection, and siting for introduction of wind-derived electricity as an integral part of the U.K. national electric grid are described. Noting that the technology to fabricate the machines exceeds the experience with applications, the construction of small test complexes of wind turbines is recommended in representative rural, coastal, and offshore sites to gain operational data and increase the ability to relate local winds to wind systems output. A hydraulic power system involving oil pumped by the rotor shaft to drive a generator at the base of the tower is planned for the U.K. WECS, producing 2 MWe at 40 rpm in a 15 m/sec wind, and 4.2 MW in a 21 m/sec wind. Control methods of arrays are examined, along with the 10-15 MW/sq km sized land-based farms. Offshore facilities are foreseen to require transmission of power to a central facility before transmission to shore to reduce costs. M.S.K.

### A82-36079

#### **A REVIEW OF THE SERI WIND ENERGY INNOVATIVE SYSTEMS PROGRAM**

I. E. VAS and P. SOUTH (Solar Energy Research Institute, Golden, CO) In: International Symposium on Wind Energy Systems, 3rd, Lyngby, Denmark, August 26-29, 1980, Proceedings. Cranfield, Beds., England, BHRA Fluid Engineering, 1980, p. 61-74. Research supported by the U.S. Department of Energy.

Features of innovative wind energy conversion systems evaluated and/or tested at the Solar Energy Research Institute are reviewed. Cost, performance, and engineering data were acquired for the machines, along with proof-of-concept demonstrations. Machines which were examined included a straight-bladed vertical axis wind turbine with circulation controlled airfoils, the Grumman tornado wind energy tower with louvers, a wind-powered charged aerosol generator which has no moving parts and gains energy directly from the wind, and the electrofluid dynamic wind driven generator for providing low-mobility charged water droplets for deriving energy from the wind. Extracting mechanical energy from vortex flows which yield the latent heat of water vapor in humid air was tested, as were the Madaras cylinders mounted on rail cars on tracks, a vortex augmentor WECS, and an oscillating vane wind energy converter. M.S.K.

### A82-36080

#### **SITES FOR WIND-POWER INSTALLATIONS - PHYSICAL MODELLING OF THE WIND FIELD OVER KAHUKU POINT, OAHU, HAWAII**

H. C. CHIEN, R. N. MERONEY, and V. A. SANDBORN (Colorado State University, Fort Collins, CO) In: International Symposium on Wind Energy Systems, 3rd, Lyngby, Denmark, August 26-29, 1980, Proceedings. Cranfield, Beds., England, BHRA Fluid Engineering, 1980, p. 75-90. Research supported by the U.S. Department of Energy. refs

### A82-36082

#### **STANDARD DEVIATIONS AND CONFIDENCE INTERVALS FOR ATMOSPHERIC DESIGN CRITERIA USED IN WECS DEVELOPMENT**

W. FROST (Tennessee, University, Tullahoma, TN) In: International Symposium on Wind Energy Systems, 3rd, Lyngby, Denmark, August 26-29, 1980, Proceedings. Cranfield, Beds., England, BHRA Fluid Engineering, 1980, p. 107-131. refs

An engineering handbook entitled Engineering Handbook on the Atmospheric Environmental Guidelines for Use in Wind Turbine Generator Development was prepared under a NASA contract to provide design criteria recommended for use in both small- and

large-scale WECS. This paper supplements the design criteria by carrying out a detailed comparison of the recommended design curves with experimental data for (1) vertical shear horizontal wind and (2) atmospheric wind speed turbulence spectra and intensities. These data are directly used in analysis of the vibration and fatigue loading of wind turbine rotor blades. (Author)

### A82-36083

#### **DEVELOPMENT OF COMPOSITE BLADES FOR LARGE WIND TURBINES**

H. W. GEWEHR (Kaman Aerospace Corp., Bloomfield, CT) In: International Symposium on Wind Energy Systems, 3rd, Lyngby, Denmark, August 26-29, 1980, Proceedings. Cranfield, Beds., England, BHRA Fluid Engineering, 1980, p. 133-140.

The design, analysis, and tests of a 150 ft length fiberglass wind turbine blade and the development of a similar set of blades for the NASA Mod-1 WECS are described. Transverse filament tape was employed in order to lower costs on the composite blades. The woven roving E-glass tape featured fibers uniformly oriented across the tape width. Components of the blade included a wound glass/epoxy spar, an E-glass/polyester trailing edge spline made from pultrusions, sandwich panels made of resin impregnated kraft paper honeycomb faced with E-glass cloth epoxy skins, and a steel hub adaptor. The blade weighed 16,300 kg. Ultimate strength properties are given, as well as costs at \$22/kg. The blades for the Mod-1 are intended to last through 400 million fatigue cycles over 30 years of operation. Details of lightning tests which proved the blade suffered minimal damage in a strike are presented. M.S.K.

### A82-36084

#### **EVOLUTION OF THE FLEXIBLE BLADE CONCEPT /VERTICAL AXIS WINDMILLS/**

J. M. DE LAGARDE (Aerowatt Co.; Montpellier, Ecole Nationale Supérieure Agronomique, Montpellier, France) In: International Symposium on Wind Energy Systems, 3rd, Lyngby, Denmark, August 26-29, 1980, Proceedings. Cranfield, Beds., England, BHRA Fluid Engineering, 1980, p. 159-168.

Operational characteristics of a panemone windmill with elastically fastened rotors are examined qualitatively and modeled numerically. The blades freely rotate at the leading edge while the trailing edge is spring-attached to the axle of the machine. The spring allows the blade to maintain a relatively constant angle of attack into the wind, thus raising the coefficient of lift in more regions of the rotation, permits self-starting, and provides efficiencies approaching that of Darrieus wind turbines. An inviscid model for panemones is developed and drag forces are considered for rigidly connected blades and for the elastically fastened rotors. The latter are found to maintain a constant circumferential speed once a maximum is reached, and then begin aerodynamic braking at another, higher limit. Optimum solidity choices are discussed. M.S.K.

### A82-36085

#### **COMBINED EFFECTS OF DETERMINISTIC AND RANDOM LOADS IN WIND TURBINE DESIGN**

A. RAAB (Sikob AB, Sweden) In: International Symposium on Wind Energy Systems, 3rd, Lyngby, Denmark, August 26-29, 1980, Proceedings. Cranfield, Beds., England, BHRA Fluid Engineering, 1980, p. 169-182. Research sponsored by the Namnden for Energiproduktionsforskning. refs

Deficiencies of modeling the deterministic loading on wind turbine blades as a cumulative sum of wind shear, mean wind, tower shadow, gravitational, and centrifugal forces are examined. It is analytically shown by application of the Palmgren-Miner rule that periodic loadings which coincide in cycle result in damage exceeding the sum of the individual stresses. The necessity of calculating the probability that coincidence of cycles will occur is stressed for making fatigue life predictions for wind turbines, and it is suggested that a weighted sum is useful for simulation or for a probabilistic interaction method. The simulation is developed in terms of sample functions for individual wind speeds. Turbulence is defined by either one- or two point spectra and applied to a

sample point on the blade. Further attention is given to fatigue evaluation as combinations of partial damages M.S.K.

#### A82-36086

##### LOAD CASES FOR WIND ENERGY CONVERSION SYSTEMS

G. TORNKVIST (Saab-Scania AB, Linköping, Sweden) In: International Symposium on Wind Energy Systems, 3rd, Lyngby, Denmark, August 26-29, 1980, Proceedings. Cranfield, Beds., England, BHRA Fluid Engineering, 1980, p. 183-192. Research supported by the Namnden for Energiproduktionsforskning. refs

Loading forces which impinge on the design of WECS are explored, based on the results of tests in the U.S. and western European countries. Wind characteristics known to influence WECS fatigue life include wind speed duration, extreme wind speed, wind shear, and turbulence. Wind speed duration is obtainable by Weibull distributions which characterize the deviation from a given wind speed in a year, and the probability that a certain speed will occur. Extreme wind speeds are found from historical data locally acquired, while turbulence is modeled in terms of resonant and nonresonant components. Wind shear is defined in gradients up to 10 m/sec. The Palmgren-Miner rule is noted to have been applied to fatigue life predictions for the NASA Mod-1 wind turbine. Finally, malfunctions during normal operating sequences including start-up, power generation, and parking are discussed. M.S.K.

#### A82-36087

##### APPLICATION OF THE FINITE ELEMENT METHOD TO THE STUDY OF THE BEHAVIOUR OF BLADES OF INDUSTRIAL WIND ENERGY SYSTEMS

J. SOREL, D. BAINVILLE, M. MAEGEY (Commissariat à l'Energie Atomique, Paris, France), J. M. NOEL, and G. SEGER (Aerowatt Co., Paris, France) In: International Symposium on Wind Energy Systems, 3rd, Lyngby, Denmark, August 26-29, 1980, Proceedings. Cranfield, Beds., England, BHRA Fluid Engineering, 1980, p. 193-206.

Finite element analyses of the stresses in the blade root of a commercially available 9.2 m diameter rotor wind turbine were performed and compared to tests results. The blades were an extruded aluminum alloy, internally ribbed with a constant cross sectional profile. Stresses are due to bolt tightening and operating conditions, including inertial loads of weight and centrifugal force. Wind loading occurs in the rotational plane and the plane perpendicular to it, generating a bending moment on the blade. The bending moment then becomes the cumulative effect of aerodynamical and gyroscopic loads. The effects of hollow blade and solid blade construction were examined to find anomalies in the stress distributions. Maximum stresses were found to be located just outside of the footing, and tests with a clamped sample blade which experienced the calculated loads revealed no permanent deformation and agreement with predicted stress. M.S.K.

#### A82-36088

##### ON WIND TURBINE POWER MEASUREMENTS

S. FRANDSEN and C. J. CHRISTENSEN (Forsøgsanlæg Riso, Roskilde, Denmark) In: International Symposium on Wind Energy Systems, 3rd, Lyngby, Denmark, August 26-29, 1980, Proceedings. Cranfield, Beds., England, BHRA Fluid Engineering, 1980, p. 207-222. refs

A statistical treatment of the wind turbine power curve is presented. It is shown that variations in  $u$  and  $p$  can be handled more conventionally by means of two parameters: The coherent variation along the power curve and the incoherent across the curve. The averaging time problem is discussed. The response of the power train to turbulence in the wind and to grid frequency variations is discussed in a spectral language. A spectral response function for the power train is derived. (Author)

#### A82-36089

##### DESCRIPTION OF THE TWO DANISH 630 KW WIND TURBINES, NIBE-A AND NIBE-B, AND SOME PRELIMINARY TEST RESULTS

B. M. PEDERSEN (Danmarks Tekniske Højskole, Lyngby, Denmark) and P. NIELSEN (DEFU, Denmark) In: International Symposium on Wind Energy Systems, 3rd, Lyngby, Denmark, August 26-29, 1980, Proceedings. Cranfield, Beds., England, BHRA Fluid Engineering, 1980, p. 223-238.

#### A82-36090

##### THE CONCEPTUAL DESIGN OF THE HIGH SPEED RATIO WIND ROTOR FOR THE 52 M DIAMETER HORIZONTAL AXIS VOITH WIND ENERGY CONVERTER

W. WEBER (Voith Getriebe, Heidenheim, West Germany) In: International Symposium on Wind Energy Systems, 3rd, Lyngby, Denmark, August 26-29, 1980, Proceedings. Cranfield, Beds., England, BHRA Fluid Engineering, 1980, p. 239-251. refs

#### A82-36091

##### DRIVE TRAIN ASSEMBLY OF THE SWEDISH WTS 3

N. G. BYGGETH, K.-E. HALLSTEN, and L. THORESON (Karlskronavarvet AB, Sweden) In: International Symposium on Wind Energy Systems, 3rd, Lyngby, Denmark, August 26-29, 1980, Proceedings. Cranfield, Beds., England, BHRA Fluid Engineering, 1980, p. 253-267.

Design features and expected operational characteristics of the Swedish WTS 3 3 MW WECS are reviewed. The wind turbine has a hub height of 80 m, a rotor diameter of 80 m, 2 blades, operates downwind, has a teetered hub, free yaw, and a 1:60 gear ratio. The blades are made of epoxy plastic and fiber glass, pitch controlled by hydraulic activation, and coupled by way of a soft shaft to the drive train. Nominal rotation is at 25 rpm, stepped up to 1500 rpm at the generator. The low speed shaft is provided with a disk brake for stopping and parking the rotor. Specific design considerations for oil drainage, the hub interface, the gear box interface, the low pressure oil return holes from the blade pitch change machinery, and the low pressure oil transfer bearing are discussed. The WTS 3 is intended for 30 yr of operation, with first rotation to have occurred in the summer of 1981. M.S.K.

#### A82-36092

##### ALTERNATOR DESIGNS FOR DIRECT COUPLING TO REMOTE WIND ENERGY SYSTEMS

R. W. MENZIES, R. M. MATHUR (Manitoba, University, Winnipeg, Canada), and W. R. BULLOCK (Bristol Aerospace, Ltd., Winnipeg, Canada) In: International Symposium on Wind Energy Systems, 3rd, Lyngby, Denmark, August 26-29, 1980, Proceedings. Cranfield, Beds., England, BHRA Fluid Engineering, 1980, p. 269-278. refs

System specifications and design considerations for the fabrication of Darrieus wind turbine generators producing up to 20 kW and operating in arctic conditions are reviewed. The conclusions are based on operation of an actual installation on an ice island in the Arctic Ocean. The 7.6 m diameter VAWT started turning in a 14 kph wind and powered the equipment at a GOES satellite relay station. To perform in hostile conditions, the generator was required to feature a low operating speed, have no drag torque at low speeds up to the start-up, yield either dc or 3-phase ac power, and be self-exciting. Major studies concentrated on inductor alternators, and numerical modeling procedures for generator efficiencies, materials, labor costs, and optimization of the airgap length are provided. A permanent magnet alternator was favored for constant voltage application up to 2 kW, while the Guy-type inductor alternator with 3-phase operation was considered best for reliable, higher power performance. M.S.K.

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**A82-36093**

### **DYNAMIC CHARACTERISTICS OF A WIND DRIVEN INDUCTION GENERATOR EQUIPPED WITH THYRISTOR CONTROLLED INDUCTANCES ON THE STATOR SIDE**

A.-A. EDRIS (Chalmers Tekniska Hogskola, Goteborg, Sweden) In: International Symposium on Wind Energy Systems, 3rd, Lyngby, Denmark, August 26-29, 1980, Proceedings. Cranfield, Beds., England, BHRA Fluids Engineering, 1980, p. 279-296. Research sponsored by the Namnden for Energiproduktionsforskning. refs

**A82-36094**

### **SOME ASPECTS OF SMALL AEROGENERATOR DESIGN AND TESTING**

I. K. BUEHRING (Exeter, University, Exeter, Devon, England) and L. L. FRERIS (Imperial College of Science and Technology, London, England) In: International Symposium on Wind Energy Systems, 3rd, Lyngby, Denmark, August 26-29, 1980, Proceedings. Cranfield, Beds., England, BHRA Fluid Engineering, 1980, p. 297-305. Research supported by the Science Research Council.

The generating and power conditioning system, the testing procedures, and the results of an analog computer simulation of small wind energy conversion system (SWECS) aerodynamics for low-cost SWECS which produce electricity for home and space heating and for grid-interface are described. Various permanent magnet alternators are considered in terms of weight, cost, and power conditioning requirements. A gear box is found to be necessary to meet demands of economy, compactness, and coupling rotor to alternator. Tests with a cambered plate, a sailing, and a single blade rotor are described in terms of performance in different wind regimes. Control strategies which were explored included uncontrolled operation with a resistive load, load switching, power feedback control, and tip speed ratio control. Best results were obtained with the tip-speed ratio control, which was concluded to be due to its characteristic of transient optimization. M.S.K.

**A82-36095**

### **STRUCTURAL DESIGN AND MAINTENANCE POLICIES FOR LARGE WIND TURBINES**

D. W. BRIDSON (Exeter, University, Exeter, Devon, England) and P. J. WORTHINGTON (Central Electricity Generating Board, Central Electricity Research Laboratories, Leatherhead, Surrey, England) In: International Symposium on Wind Energy Systems, 3rd, Lyngby, Denmark, August 26-29, 1980, Proceedings. Cranfield, Beds., England, BHRA Fluid Engineering, 1980, p. 307-321. refs

Aerospace structural design and maintenance policies are reviewed to find policies and procedures suitable for applications to large WECS. Failures occurring from fatigue, corrosion, fretting, erosion, and water ingestion in composites are noted to be predictable to a limited degree, while failure due to overspeed overloading, ice accretion, and accidents are random. Acceptable risk levels are computed and components which cannot be allowed to fail are identified. Fatigue testing procedures which can accurately reflect the expected fatigue life of structural components are outlined, and test results are employed to develop reliable inspection schedules. The introduction of fail-safe design through multiple load paths ensures that no catastrophic failure can occur before inspection due to a transfer of load-bearing burden to structural parts which have not failed. Routine and opportunity visual and nondestructive WECS inspection are described. M.S.K.

**A82-36097**

### **'L-180 POSEIDON' - A NEW SYSTEM CONCEPT IN VERTICAL AXIS WIND TURBINE TECHNOLOGY**

O. LJUNGSTROM (Flygtekniska Forsoksanstalten, Bromma, Sweden) In: International Symposium on Wind Energy Systems, 3rd, Lyngby, Denmark, August 26-29, 1980, Proceedings. Cranfield, Beds., England, BHRA Fluid Engineering, 1980, p. 333-355. Research supported by the Styrelsen for Teknisk Utveckling and Namnden for Energiproduktionsforskning. refs

Operating and design characteristics, along with costs of the 20 MW Poseidon L-180 vertical axis wind turbine (VAWT) for offshore siting are described. The total height is projected to be

210 m, with a turbine diameter of 180 m. Double airfoil blades are attached at one point at the top of the tower and to a base ring with a 60 m diameter at the center of the tower. The two sets of dual blades mounted 90 deg apart would propel the base ring in a track around the tower at 6.4 rpm on rollers, of which every fourth would be a generator. The L-shape of the blade arrangements has been demonstrated to reduce rotor loading oscillations in wind tunnel tests, and additional calculations have shown that reduced loads in parking situations in high winds permit the construction of the 20 MW-sized machine. The design of the machine is noted to be unsuitable in smaller sizes, and construction of the 2.25 m chord blades is detailed. The L-180 is projected to produce 44.5 GWh/yr at 9.5 m/sec mean speeds. M.S.K.

**A82-36098**

### **A VORTEX-WAKE ANALYSIS OF A HORIZONTAL-AXIS WIND TURBINE AND A COMPARISON WITH A MODIFIED BLADE-ELEMENT THEORY**

M. B. ANDERSON (Cambridge University, Cambridge, England) In: International Symposium on Wind Energy Systems, 3rd, Lyngby, Denmark, August 26-29, 1980, Proceedings. Cranfield, Beds., England, BHRA Fluid Engineering, 1980, p. 357-374. Research supported by the Science Research Council. refs

A theoretical method is developed for determining the geometry and strength distribution of the vortex-wake generated by a horizontal-axis wind turbine. The angle of relative flow and induced velocities are compared with those from a modified blade-element theory. The blade-element theory includes tip losses which are evaluated from either the Goldstein or Prandtl solution of the potential flow about a helical vortex sheet. (Author)

**A82-36099**

### **THE 25 M EXPERIMENTAL HORIZONTAL AXIS WIND TURBINE /25 M HAT/**

F. J. C. SCHELLEN (FDO Technische Adviseurs, Amsterdam, Netherlands) In: International Symposium on Wind Energy Systems, 3rd, Lyngby, Denmark, August 26-29, 1980, Proceedings. Cranfield, Beds., England, BHRA Fluid Engineering, 1980, p. 375-390.

Design consideration and physical dimensions of a 25-m diameter experimental horizontal axis wind turbine (HAWT) in the Netherlands are presented. The turbine is intended for operation in the 5-6 to 17 m/sec regime, yielding an operating time of 4711 hr/yr at a site with a 3258 kWh/sq m/yr wind regime. The HAWT is equipped with a pitch change mechanism for coupling to a dc generator and dc/ac converter. A tip-speed ratio of 8 was chosen, yielding a rotor speed of 8.37 rad/sec, a power coefficient of 0.46, shaft power of 302 kW, and a blade twist of 14.7 deg. An average power of 57 kW is expected. Limiting load conditions which impinge on fatigue and elastic deformation behavior are described, noting the large damping modes present due to the use of a concrete tower. The HAWT is an upwind configuration, with a 1/20 gear ratio, a line-commutated converter, and active yaw control. M.S.K.

**A82-36100**

### **TESTS PERFORMED ON THE 2 MW TVIND WECS**

S. A. JENSEN and E. T. D. BJERREGAARD (Danish Ship Research Laboratory, Denmark) In: International Symposium on Wind Energy Systems, 3rd, Lyngby, Denmark, August 26-29, 1980, Proceedings. Cranfield, Beds., England, BHRA Fluid Engineering, 1980, p. 391-400.

Results from a 16-channel monitoring program on the Tvind 2 MW wind turbine are presented. The WECS has a rotor diameter of 54 m, three blades, operates downwind, has a cone angle of 9 deg, a tilt angle of 4 deg and each blade is constructed of glass-fiber reinforced epoxy. The blades were monitored for strain angular velocity, and position, the shaft for torque, and additional data were gathered on the linear acceleration of the nacelle, the wind speed at hub height, and the wind direction relative to the rotor. A difference in the center of mass of one of the three blades was detected during the torque measurements. The blade was also observed to experience tensile and compressive stresses,

with variations due to gravitational forces. Measurements of the tower wake effect on the torque and blade strains were not possible. M.S.K.

#### A82-36101

##### THE EFFICIENCY OF WIND TURBINE CLUSTERS

E. A. BOSSANYI, G. E. WHITTLE, P. D. DUNN, N. H. LIPMAN, P. J. MUSGROVE (Reading, University, Reading, Berks., England), and C. MACLEAN (Reading, University, Reading, Berks.; Science and Engineering Research Council, Rutherford Appleton Laboratory, Didcot, Oxon, England) In: International Symposium on Wind Energy Systems, 3rd, Lyngby, Denmark, August 26-29, 1980, Proceedings. Cranfield, Beds., England, BHRA Fluid Engineering, 1980, p. 401-416. refs

A computer simulation for the prediction of wind depletion in an array of wind turbines is presented, along with a discussion of the deficiencies and possible improvements in current array prediction techniques. Formulations for determining the available wind velocity profile without, with one, and with the addition of a cluster of wind turbines are explored analytically. Various values for the friction velocity, surface roughness length, and boundary layer thickness are derived. A computer simulation is detailed, taking as input a WECS' operating characteristics and wind speed and as output yields the power and the drag coefficient. It is found that clustering decreases the optimum rated wind speed, that the magnitude of decrease is dependent on the type of machine considered, and that difficulties exist in transferring wind tunnel data to actual wind turbine arrays. M.S.K.

#### A82-36102

##### MODELLING OF WIND TURBINE ARRAYS

P. J. H. BULTJES (Centrale Organisatie voor Toegepast-Natuurwetenschappelijk Onderzoek, The Hague, Netherlands) and D. J. MILBORROW (Central Electricity Generating Board, Central Electricity Research Laboratories, Leatherhead, Surrey, England) In: International Symposium on Wind Energy Systems, 3rd, Lyngby, Denmark, August 26-29, 1980, Proceedings. Cranfield, Beds., England, BHRA Fluid Engineering, 1980, p. 417-430. refs

Results derived from two sets of wind turbine wind tunnel tests are compared, with emphasis on the accuracy of modeling techniques and the effects of scale. Despite differences in approach, agreement is found between the sets of results, and comparisons with theoretical studies indicate that wind turbine array outputs can be predicted with reasonable accuracy. Although loss of power due to interactive effects is dependent on such factors as the size of the array and the spacing between its units, it is found that losses can be kept to within 20%. It is concluded that cluster configurations with spacings of 5 to 12 rotor diameters will yield power densities on the order of 2-10 mW per kilometer of surface. O.C.

#### A82-36104

##### ON WAKE DECAY AND ROW SPACING FOR WECS FARMS

P. A. TAYLOR (Department of the Environment, Atmospheric Environment Service, Ottawa, Canada) In: International Symposium on Wind Energy Systems, 3rd, Lyngby, Denmark, August 26-29, 1980, Proceedings. Cranfield, Beds., England, BHRA Fluid Engineering, 1980, p. 451-468. refs

A numerical model of wakes in the neutrally stratified atmospheric boundary layer is developed and applied to the flow behind horizontal and vertical axis wind turbines. The model is linearized, uses boundary layer approximations and is integrated across turbine rows but should still provide useful estimates of power reductions at turbines in second and subsequent rows of a WECS farm array. Variations with turbine size and other characteristics are investigated as well as variations due to different surface roughness, wind speed and direction. Comparisons are made with other theories of wake interactions and with wind tunnel investigations. (Author)

#### A82-36106

##### THE STATUS OF WINDPOWER RESEARCH AND DEVELOPMENT FOR SPACE AND WATER HEATING IN THE UNITED STATES

D. E. CROMACK, J. G. MCGOWAN, and W. E. HERONEMUS (Massachusetts, University, Amherst, MA) In: International Symposium on Wind Energy Systems, 3rd, Lyngby, Denmark, August 26-29, 1980, Proceedings. Cranfield, Beds., England, BHRA Fluid Engineering, 1980, p. 485-498. Research supported by the U.S. Department of Energy. refs

#### A82-36107

##### SUBSTITUTION OF DIESEL POWER PLANTS BY SOLAR AND WIND ELECTRICITY GENERATORS - A CASE STUDY FOR A TROPICAL ISLAND

R. MINDER (Electrowatt Engineering Services, Ltd., Zurich, Switzerland) and D. GILBY (Electrowatt Engineering Services, Ltd., England) In: International Symposium on Wind Energy Systems, 3rd, Lyngby, Denmark, August 26-29, 1980, Proceedings. Cranfield, Beds., England, BHRA Fluid Engineering, 1980, p. 521-531.

#### A82-36108

##### A REGIONAL WIND-HYDRO ELECTRICITY SUPPLY SYSTEM

B. SORENSEN (Copenhagen, University, Copenhagen, Denmark) In: International Symposium on Wind Energy Systems, 3rd, Lyngby, Denmark, August 26-29, 1980, Proceedings. Cranfield, Beds., England, BHRA Fluid Engineering, 1980, p. 533-543. refs

A simulation for a wind-hydro storage system involving a large wind turbine capacity in Denmark reciprocating with the 100% hydro system in Norway is described. A transfer capability either way of 5 GW was assumed for a system in which Denmark would receive hydro-generated electricity when insufficient winds were available in Denmark and Norway would buy wind-derived power to replace hydro power, thus effectively storing fuel, when winds were strong in Denmark. The model included diurnal and seasonal load and wind availability fluctuations, in addition to the historical power capacity of Norwegian hydro. The Danish/Norwegian power ratio was set at 0.3, and Danish wind-produced electricity was found to penetrate the Norwegian system by 3%. Losses from transmission were calculated to be 8% of the wind production. The combined wind/hydro system is noted to eliminate the necessity for thermal power station back-up. M.S.K.

#### A82-36109

##### A SIMULATION MODEL OF AN ELECTRICITY GENERATING SYSTEM INCORPORATING WIND TURBINE PLANT

G. E. WHITTLE, E. A. BOSSANYI, P. D. DUNN, N. H. LIPMAN, P. J. MUSGROVE (Reading, University, Reading Berks., England), and C. MACLEAN (Reading, University, Reading, Berks.; Science and Engineering Research Council, Rutherford Appleton Laboratory, Didcot, Oxon England) In: International Symposium on Wind Energy Systems, 3rd, Lyngby, Denmark, August 26-29, 1980, Proceedings. Cranfield, Beds., England, BHRA Fluid Engineering, 1980, p. 545-554. refs

#### A82-36110

##### THE CAPACITY CREDIT OF WIND POWER - A NUMERICAL MODEL

B. MARTIN (Australian National University, Canberra, Australia) and M. DIESENDORF (Commonwealth Scientific and Industrial Research Organization, Div. of Mathematics and Statistics, Canberra, Australia) In: International Symposium on Wind Energy Systems, 3rd, Lyngby, Denmark, August 26-29, 1980, Proceedings. Cranfield, Beds., England, BHRA Fluid Engineering, 1980, p. 555-564. Research supported by the National Energy Research, Development and Demonstration Council. refs

A numerical probabilistic model was formulated to evaluate wind-derived electricity capacity credit as a function of grid penetration levels and the model's sensitivity to several parameters. The simulation included loss of load probability as the fraction of time capacity was less than load, the effective load carrying capacity which could be maintained at different levels of windpower penetration, and a standard wind turbine operating from 4-40

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m/sec. Inputs comprised hourly load and wind data, individual unit capacities, forced outages, start-up times, etc. The available wind speed distributions were varied, as were the grid generating composition, the load distribution, and the WECS characteristics. Capacity credit was found to be equal to the average wind power for small WECS penetration, about 0.4 of the available wind energy at 20% penetration, and to reach a constant value at large penetrations. M.S.K.

### A82-36111

#### WIND ENERGY IN ARGENTINA

R. A. BASTIANON (Research and Development Naval Service, Argentina) In: International Symposium on Wind Energy Systems, 3rd, Lyngby, Denmark, August 26-29, 1980, Proceedings. Cranfield, Beds., England, BHRA Fluid Engineering, 1980, p. 565-570.

The potential for wind energy generation in Argentina is discussed, and ongoing projects are described. Anemometers have been installed in Patagonia to measure wind speeds at various locations and heights, and an experimental windmill consisting of vanes confined in a cylinder has been tested in a wind tunnel. The economic circumstances of Patagonia and the southern islands are discussed and it is argued that wind power would improve the situation there. The first serious attempt to build a high-performance wind turbine in Argentina is described. C.D.

### A82-36112

#### A VERTICAL AXIS WIND ENERGY CONVERTER WITH STRAIGHT BLADES

H. G. REIMERDES (Aachen, Rheinisch-Westfaelische Technische Hochschule, Aachen, West Germany) In: International Symposium on Wind Energy Systems, 3rd, Lyngby, Denmark, August 26-29, 1980, Proceedings. Symposium sponsored by the British Hydromechanics Research Association. Cranfield, Beds., England, BHRA Fluid Engineering, 1980. 20 p. refs

Engineering considerations and the design of a two-bladed vertical axis wind turbine (VAWT) capable of producing 20 kW in a 7 m/sec wind are presented. An airfoil with a NACA 65(4)-021 profile was chosen, along with equal height-to-diameter ratio, operation at 5-15 m/sec, rotation at 21/min, and a maximum lift coefficient at rated speed. Using diagonal struts for support was found to produce both drag and propulsive forces, with the total drag calculated to be 0.026 for the blades. Wind tunnel tests on a scale model revealed that the required 20 kW could not be attained at the 7 m/sec level, but could at higher speeds, improving the total annual energy output by 20%. Further investigations covered mass forces, wind loading in different operational modes, starting and braking, and snow and ice loads. Wood was chosen as the main structural material to permit ready repairs in developing nations. M.S.K.

### A82-36113

#### THE SOUTHERN CALIFORNIA DESERT WIND-ENERGY ASSESSMENT

E. X. BERRY (Atmospheric Research and Technology, Inc., Sacramento, CA), R. K. HAUSER, W. G. LANE (California State University, Chico, CA), and J. B. PARK, II In: International Symposium on Wind Energy Systems, 3rd, Lyngby, Denmark, August 26-29, 1980, Proceedings. Symposium sponsored by the British Hydromechanics Research Association. Cranfield, Beds., England, BHRA Fluid Engineering, 1980. 12 p. Research supported by the California Energy Commission.

The goals of the ongoing Project Windesert, which has established 25 new microprocessor-based meteorological stations in the southern California desert, are reported. Surface winds are being mapped for windpower applications, and determinations are being made of the level of detail required, the flows over complex terrain, and methodology. The Universal Mercator system was employed to define 10,000 sq km areas within the 90,000 sq km project area. In comparisons of data gathered at different sites, it was found that use of the zonal wind as a climatological base will underestimate the wind regime locally. No general rule of increase of wind speeds with height was implied by the data, and Rayleigh distributions were found to be invalid for predicting available wind

power. Indications of enhanced winds over ridges and in troughs were documented. Finally, techniques for ensuring the success of a field-oriented wind survey are reported. M.S.K.

### A82-36209

#### ECONOMIC ANALYSIS OF SMALL WIND-ENERGY CONVERSION SYSTEMS

B. N. HAACK (Ball State University, Muncie, IN) Applied Energy, vol. 11, May 1982, p. 51-60. refs

A computer simulation was developed for evaluating the economics of small wind energy conversion systems (SWECS). Input parameters consisted of initial capital investment, maintenance and operating costs, the cost of electricity from other sources, and the yield of electricity. Capital costs comprised the generator, tower, necessity for an inverter and/or storage batteries, and installation, in addition to interest on loans. Wind data recorded every three hours for one year in Detroit, MI was employed with a 0.16 power coefficient to extrapolate up to hub height as an example, along with 10 yr of use variances. A maximum return on investment was found to reside in using all the energy produced on site, rather than selling power to the utility. It is concluded that, based on a microeconomic analysis, SWECS are economically viable at present only where electric rates are inordinately high, such as in remote regions or on islands. M.S.K.

### A82-36394

#### FRANCE'S SUPERFAST TRAIN

J. DUPUY (Societe Nationale des Chemins de Fer Francais, Paris, France) IEEE Spectrum, vol. 19, July 1982, p. 38-43. refs

Operational characteristics and the testing program for the high speed French National Railroad TGV passenger train service between Paris and southeastern France are described. The train speed is optimized at between 250-300 km/hr on routing that includes 390 km of new track and 36 km of conventional track. Each train set has two power units and eight passenger coaches which draw a total power of 6300 kW from 25 kV lines along the track. The cars were designed with a three meter base, a low carriage, rheostatic and disk brakes, and aerodynamic profiling to reduce air drag. Switching and warning signals are incorporated in the operators console, which receives coded signals from each 3000-m long segment of track to indicate broken rails, power-outs, or oncoming trains. M.S.K.

### A82-37077#

#### USE OF PULTRUDED REINFORCED PLASTICS IN ENERGY GENERATION AND ENERGY RELATED APPLICATIONS

R. ANDERSON (Morrison Molded Fiberglass Co., Bristol, VA) In: Reinforced Plastics/Composites Institute, Annual Conference, 36th, Washington, DC, February 16-20, 1981, Preprints. New York, Society of the Plastics Industry, Inc., 1981 (Session 22-B). 3 p.

Applications of pultrusion-formed fiber-reinforced plastics (FRP) in the wind, oil, and coal derived energy industries are reviewed. FRP is noted to be a viable alternative to wood, aluminum, and steel for reasons of availability, price, and weight. Attention is given to the development of FRP wind turbine blades for the DOE 8 kW low cost, high reliability wind turbine program. The blades feature a NACA 23112 profile with a 15 in. chord on the system which was tested at Rocky Flats, CO. Fabricating the blades involved a plus and minus 45 deg roving orientation, a heavy fiber-glass nose piece to assure blade strength, and a separately manufactured foam core. Additional uses for FRP products have been found in the structural members of coal stack scrubbers using a vinyl ester resin in a fire retardant formulation, and as low cost, light weight sucker rods for deep well oil drilling. M.S.K.

A82-37549

**DETERMINATION OF TEMPERATURE DISTRIBUTION IN THE FLOW OF A HOT GAS ON THE BASIS OF A SELF-REVERSED SPECTRAL LINE PROFILE [OPREDELENIE TEMPERATURNOGO RASPREDELENIIA V POTOKE GORACHEGO GAZA PO KONTURU SAMOBRASHCHENNOI SPEKTRAL'NOI LINII]**

I. A. VASILEVA, A. V. ORLOV, A. S. URINSON (Akademii Nauk SSSR, Institut Vysokikh Temperatur, Moscow, USSR), S. GENDZHOV, and B. STEFANOV (B'lgarska Akademiia na Naukite, Institut po Elektronika, Sofia, Bulgaria) Akademii Nauk SSSR, Doklady, vol. 264, no. 4, 1982, p. 853-856. In Russian. refs

The paper describes a method for determining the temperature distribution in a hot-gas flow on the basis of measurements of self-reversed spectral line profiles along one line of sight. A remotely controlled scanning monochromator was used to measure profiles of the resonance doublet of potassium at 7665 and 7699 Å in a flow of combustion products of natural gas with a potassium additive in an MHD facility. Results show that this particular method of determining the temperature distribution in an inhomogeneous flow of radiating gas is particularly applicable to the study of boundary layers in MHD systems. B.J.

A82-37577

**DESIGN AND PERFORMANCE CHARACTERISTICS OF A CW SUBSONIC HF CHEMICAL LASER WITH 120 W POWER OUTPUT**

Z. BABAROGIC, I. BELIC, I. MENDAS, and M. TRTICA (Beograd, Univerzitet, Belgrade, Yugoslavia) Review of Scientific Instruments, vol. 53, July 1982, p. 949-951. refs

A transverse flow CW subsonic HF chemical laser is presented which provides up to 46 and 120 W CW output power when argon and helium, respectively, are used as diluent gases. The HF laser power is found to be approximately a linear function of the discharge electrical input power, indicating a constant electrical-to-laser power conversion efficiency of about 0.4%. The best achieved value of the chemical efficiency is about 1.2%, using argon as a diluent gas; the specific power corresponding to the maximum output power of 46 W is about 13 J/g. V.L.

A82-37627

**THE EFFECT OF SULFUR ON THE ANODIC H<sub>2</sub> /NI/ ELECTRODE IN FUSED Li<sub>2</sub>CO<sub>3</sub>-K<sub>2</sub>CO<sub>3</sub> AT 650 C**

W. M. VOGEL and S. W. SMITH (United Technologies Corp., Power Systems Div., South Windsor, CT) Electrochemical Society, Journal, vol. 129, July 1982, p. 1441-1445. Research supported by the U.S. Department of Energy. refs

The effects of sulfur on the reaction of H<sub>2</sub> at a nickel anode in a molten Li<sub>2</sub>CO<sub>3</sub>-K<sub>2</sub>CO<sub>3</sub> fuel cell at 650 C are investigated. Steady-state polarization curves for rotating Ni wires were determined in the presence of H<sub>2</sub> gas containing varying amounts of H<sub>2</sub>S. In the absence of sulfur, the diffusion-limiting currents are observed to be only slightly larger than the limiting currents, while the introduction of H<sub>2</sub>S leads to a reduction in limiting currents which may be attributed to the poisoning of the Tafel reaction which converts molecular hydrogen into a metal hydride. Results suggest a saturation of the sulfur effect at an H<sub>2</sub>S/H<sub>2</sub> pressure ratio of about 0.0001, although the sulfur-saturated Ni surface retains a finite activity for H<sub>2</sub> oxidation. An approximate rate equation for H<sub>2</sub> oxidation is also derived for small sulfur coverages. A.L.W.

A82-37971#

**THE AGE OF FUSION - ON THE BRINK**

S. WALTERS Mechanical Engineering, vol. 104, July 1982, p. 22-33.

The state of the art on magnetic fusion energy reactors is discussed in detail, and extensive diagrams of the different reactor designs as well as projected timetables for future advances in fusion capabilities are presented. During the 1980s, the scientific feasibility of fusion power will be tested in the US at the Tokamak Fusion Test Reactor (TFTR), and while the TFTR will not generate any electricity, it will be the first magnetic fusion system in the

US capable of producing fusion energy in any significant quantity (30 MW). It will also be the first US system to use a deuterium-tritium fuel mixture, thus allowing studies to be conducted under reactor conditions. In addition, the TFTR incorporates a tritium-breeding blanket experiment, which will be used to test several features necessary for commercial fusion reactors. Another fusion reactor design showing promise is the magnetic mirror machine, a linear system utilizing magnetic mirrors to contain the plasma, and having several advantages over the tokamak-type machines. An example of this type of system, the Magnetic Mirror Test Facility, is scheduled to go into operation in the mid-1980s and will approach the energy break-even point, noting that recent tests of the superconducting magnet coils for this reactor achieved design expectations in all respects. N.B.

N82-22275# Rolls-Royce Ltd., Derby (England).

**RELIABLE POWER**

J. M. S. KEEN Feb. 1981 21 p Presented at Intern. Aircraft Maintenance Eng. Exhibition and Conf., Zurich, Feb. 1981 (PNR-90078) Avail: NTIS HC A02/MF A01

The Rolls Royce RB211 engine design is reviewed. The three shaft concept increases engine thrust and cuts fuel consumption. The highest thrust version of the RB211 cuts fuel consumption of Boeing 747's by 17%. The 535E4 blends turbine and bypass flows in a buried nozzle within a longer cowl. The resultant gases are exhausted through a single final nozzle. This device provides an automatic rematching of the engine cycle at climb ratings, thereby saving fuel and reducing turbine entry temperature. Reverse thrust is increased by up to 38% relative to an unmixed engine. The on-condition maintenance policy reduces costs without reducing safety. The reliability management program ensures the most cost effective maintenance schedule. Author (ESA)

N82-22327\*# National Aeronautics and Space Administration. Lewis Research Center, Cleveland, Ohio.

**CROSS-LINKED POLYVINYL ALCOHOL FILMS AS ALKALINE BATTERY SEPARATORS**

D. W. SHEIBLEY, M. A. MANZO, and O. D. GONZALEZ-SANABRIA Mar. 1982 19 p refs Presented at the 158th Meeting of the Electrochim. Soc., Hollywood, Fla., 5-10 Oct. 1980

(NASA-TM-82802; E-1141; NAS 1.15:82802) Avail: NTIS HC A02/MF A01 CSCL 07D

Cross-linking methods were investigated to determine their effect on the performance of polyvinyl alcohol (PVA) films as alkaline battery separators. The following types of cross-linked PVA films are discussed: (1) PVA-dialdehyde blends post-treated with an acid or acid periodate solution (two-step method) and (2) PVA-dialdehyde blends cross-linked during film formation (drying) by using a reagent with both aldehyde and acid functionality (one-step method). Laboratory samples of each cross-linked type of film were prepared and evaluated in standard separator screening tests. The pilot-plant batches of films were prepared and compared to measure differences due to the cross-linking method. The pilot-plant materials were then tested in nickel oxide - zinc cells to compare the two methods with respect to performance characteristics and cycle life. Cell test results are compared with those from tests with Celgard. Author

**N82-22441# United Technologies Corp., South Windsor, Conn. AC/DC POWER CONVERTER FOR BATTERIES AND FUEL CELLS Final Report**

R. W. ROSATI, C. V. BANIC, F. J. KORNBRUST, J. L. PETERSON, and B. R. WILL Sep. 1981 231 p refs Sponsored by Electric Power Research Inst.

(Contract EPRI PROJ. 841-1) (DE82-900867; EPRI-EM-2031) Avail: NTIS HC A11/MF A01

The results of a program to design an advanced power converter for use in battery energy storage and fuel cell generation systems in the 1980s are presented. The design analysis, including each major subsystem and component, various ways of optimizing a 14-MW wide-range converter, and the requirements for some of the converter components are described. An assessment of the

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basic program is included, and a number of future program needs are identified. M.D.K.

**N82-22502#** Curtiss-Wright Corp., Wood-Ridge, N.J.  
**HIGH-TEMPERATURE-TURBINE TECHNOLOGY PROGRAM.**  
**PHASE 2: TECHNOLOGY TEST AND SUPPORT STUDIES.**  
**TURBINE SPOOL TECHNOLOGY RIG CASCADE TESTS**

Jun. 1981 95 p

(Contract DE-AC01-76ET-10348)

(DE81-030352; DOE/ET-10348/T3; FE-2291-76;

CW-WR-76-020.76A) Avail: NTIS HC A05/MF A01

Integrated gas turbine combined cycle electric power generating systems offer the promise for using coal in an economic and environmentally acceptable manner. Powerplant efficiencies well above 40% may be achieved with gas turbine firing temperatures of 26000 F and higher, if the turbine cooling requirements are not excessive. Transpiration air cooling protects turbine components from the aggressive environment produced by the combustion of coal derived fuels. A new single stage, high work transpiration air cooled turbine was designed and fabricated for evaluation in a rotating test vehicle designated the turbine spool technology rig (TSTR). Prior to operating the TSTR, a cascade test program was conducted on a 10 vane sector to determine the cooling characteristics of these parts and to develop changes as required to assure satisfactory operation of the TSTR. The cascade program is described including several changes incorporated into the vanes. DOE

**N82-22649\*#** National Aeronautics and Space Administration.  
Lewis Research Center, Cleveland, Ohio.

**EFFECT OF ROTOR CONFIGURATION ON GUYED TOWER AND FOUNDATION DESIGNS AND ESTIMATED COSTS FOR INTERMEDIATE SITE HORIZONTAL AXIS WIND TURBINES**

G. R. FREDERICK (Toledo Univ.), J. R. WINEMILLER, and J. M. SAVINO Mar. 1982 39 p refs

(NASA-TM-82804; DOE/NASA/20320-39; NAS 1.15:82804)

Avail: NTIS HC A03/MF A01 CSCL 10B

Three designs of a guyed cylindrical tower and its foundation for an intermediate size horizontal axis wind turbine generator are discussed. The primary difference in the three designs is the configuration of the rotor. Two configurations are two-blade rotors with teetering hubs - one with full span pitchable blades, the other with fixed pitch blades. The third configuration is a three-bladed rotor with a rigid hub and fixed pitch blades. In all configurations the diameter of the rotor is 38 meters and the axis of rotation is 30.4 meters above grade, and the power output is 200 kW and 400 kW. For each configuration the design is based upon for the most severe loading condition either operating wind or hurricane conditions. The diameter of the tower is selected to be 1.5 meters (since it was determined that this would provide sufficient space for access ladders within the tower) with guy rods attached at 10.7 meters above grade. Completing a design requires selecting the required thicknesses of the various cylindrical segments, the number and diameter of the guy rods, the number and size of soil anchors, and the size of the central foundation. The lower natural frequencies of vibration are determined for each design to ensure that operation near resonance does not occur. Finally, a cost estimate is prepared for each design. A preliminary design and cost estimate of a cantilever tower (cylindrical and not guyed) and its foundation is also presented for each of the three configurations. Author

**N82-22659\*#** Jet Propulsion Lab., California Inst. of Tech., Pasadena.

**HELICAL SCREW EXPANDER EVALUATION PROJECT Final Report**

R. MCKAY 1 Mar. 1982 457 p refs

(Contract NAS7-100; DE-AI01-76ET-28329; EX-71-1-01-1000)

(NASA-CR-168803; JPL-PUB-82-5; NAS 1.26:168803;

DOE/ET-28329/1) Avail: NTIS HC A20/MF A01 CSCL 10A

A one MW helical rotary screw expander power system for electric power generation from geothermal brine was evaluated. The technology explored in the testing is simple, potentially very

efficient, and ideally suited to wellhead installations in moderate to high enthalpy, liquid dominated field. A functional one MW geothermal electric power plant that featured a helical screw expander was produced and then tested with a demonstrated average performance of approximately 45% machine efficiency over a wide range of test conditions in noncondensing, operation on two-phase geothermal fluids. The Project also produced a computer equipped data system, an instrumentation and control van, and a 1000 kW variable load bank, all integrated into a test array designed for operation at a variety of remote test sites. Data are presented for the Utah testing and for the noncondensing phases of the testing in Mexico. Test time logged was 437 hours during the Utah tests and 1101 hours during the Mexico tests. S.L.

**N82-22661\*#** Jet Propulsion Lab., California Inst. of Tech., Pasadena.

**THEORY AND TESTS OF TWO-PHASE TURBINES**

D. G. ELLIOTT 15 Mar. 1982 149 p refs

(Contract NAS7-100; DE-AI01-80ER-10614)

(NASA-CR-168834; JPL-PUB-81-105; NAS 1.26:168834;

DOE/ER-10614/1) Avail: NTIS HC A07/MF A01 CSCL 10B

A theoretical model for two-phase turbines was developed. Apparatus was constructed for testing one- and two-stage turbines (using speed decrease from stage to stage). Turbines were tested with water and nitrogen mixtures and refrigerant 22. Nozzle efficiencies were 0.78 (measured) and 0.72 (theoretical) for water and nitrogen mixtures at a water/nitrogen mixture ratio of 68, by mass; and 0.89 (measured) and 0.84 (theoretical) for refrigerant 22 expanding from 0.02 quality to 0.28 quality. Blade efficiencies (shaft power before windage and bearing loss divided by nozzle jet power) were 0.63 (measured) and 0.71 (theoretical) for water and nitrogen mixtures and 0.62 (measured) and 0.63 (theoretical) for refrigerant 22 with a single stage turbine, and 0.70 (measured) and 0.85 (theoretical) for water and nitrogen mixtures with a two-stage turbine. Author

**N82-22671#** Little (Arthur D.), Inc., Cambridge, Mass.

**NEAR-TERM HIGH POTENTIAL COUNTIES FOR SWECS Final Report**

W. C. OSBORN and W. T. DOWNEY Golden, Colo. Midwest Research Inst. Feb. 1981 103 p refs Prepared for Midwest Research Inst., Golden, Colo.

(Contract EG-77-C-01-4042)

(SERI/TR-98282-11) Avail: NTIS HC A06/MF A01

Up-to-date market information to manufacturers of small wind energy conversion system (SWECS) to assist them in developing marketing strategies for their products are provided. The data are arranged in a format that permits rapid identification of a particular location or market segment for further investigation. Extensive backup information by state and county in state SWECS Market reports are appended. It is suggested that the information are useful to SWECS manufacturers for planning new marketing and advertising activities. Background information essential to market studies is synthesized and an initial framework to start such a study is provided. Author

**N82-23121\*#** Le Tourneau Coll., Longview, Tex.

**ORBITER FUEL CELL IMPROVEMENT ASSESSMENT**

R. E. JOHNSON In Houston Univ. The 1981 NASA ASEE Summer Fac. fellowship Program, Vol. 1 27 p 20 Aug. 1981 refs

Avail: NTIS HC A14/MF A01 CSCL 10A

The history of fuel cells and the theory of fuel cells is given. Expressions for thermodynamic and electrical efficiencies are developed. The voltage losses due to electrode activation, ohmic resistance and ionic diffusion are discussed. Present limitations of the Orbiter Fuel Cell, as well as proposed enhancements, are given. These enhancements are then evaluated and recommendations are given for fuel cell enhancement both for short-range as well as long-range performance improvement. Estimates of reliability and cost savings are given for enhancements where possible. Author

**N82-23678\*#** National Aeronautics and Space Administration. Lewis Research Center, Cleveland, Ohio.

**PARAMETRIC PERFORMANCE ANALYSIS OF STEAM-INJECTED GAS TURBINE WITH A THERMIONIC-ENERGY-CONVERTER-LINED COMBUSTOR**  
Y. K. CHOO and R. K. BURNS Feb. 1982 21 p refs  
(NASA-TM-82736; E-1048; NAS 1.15:82736) Avail: NTIS HC A02/MF A01 CSCL 10B

The performance of steam-injected gas turbines having combustors lined with thermionic energy converters (STIG/TEC systems) was analyzed and compared with that of two baseline systems; a steam-injected gas turbine (without a TEC-lined combustor) and a conventional combined gas turbine/steam turbine cycle. Common gas turbine parameters were assumed for all of the systems. Two configurations of the STIG/TEC system were investigated. In both cases, steam produced in an exhaust-heat-recovery boiler cools the TEC collectors. It is then injected into the gas combustion stream and expanded through the gas turbine. The STIG/TEC system combines the advantage of gas turbine steam injection with the conversion of high-temperature combustion heat by TEC's. The addition of TEC's to the baseline steam-injected gas turbine improves both its efficiency and specific power. Depending on system configuration and design parameters, the STIG/TEC system can also achieve higher efficiency and specific power than the baseline combined cycle. Author

**N82-23679\*#** National Aeronautics and Space Administration. Lewis Research Center, Cleveland, Ohio.

**EVALUATION OF LIGHTNING ACCOMMODATION SYSTEMS FOR WIND-DRIVEN TURBINE ROTORS Final Report**  
H. BANKAITIS Mar. 1982 49 p refs  
(Contract DE-AI01-76ET-20320)  
(NASA-TM-82784; E-1116; DOE/NASA/20320-37; NAS 1.15:82784) Avail: NTIS HC A03/MF A01 CSCL 10B

Wind-driven turbine generators are being evaluated as an alternative source of electric energy. Areas of favorable location for the wind-driven turbines (high wind density) coincide with areas of high incidence of thunderstorm activity. These locations, coupled with the 30-m or larger diameter rotor blades, make the wind-driven turbine blades probable terminations for lightning strikes. Several candidate systems of lightning accommodation for composite-structural-material blades were designed and their effectiveness evaluated by submitting the systems to simulated lightning strikes. The test data were analyzed and system design were reviewed on the basis of the analysis. T.M.

**N82-23684\*#** National Aeronautics and Space Administration. Lewis Research Center, Cleveland, Ohio.

**WIND TURBINE DYNAMICS**  
R. W. THRESHER, ed. (Oregon State Univ., Corvallis) May 1981 422 p refs Workshop held in Cleveland 24-26 Feb. 1981 Sponsored in part by DOE  
(NASA-CP-2185; NAS 1.55:2185; CONF-810226; SERI/CP-635-1238) Avail: NTIS HC A18/MF A01 CSCL 10B

Recent progress in the analysis and prediction of the dynamic behavior of wind turbine generators is discussed. The following areas were addressed: (1) the adequacy of state of the art analysis tools for designing the next generation of wind power systems; (2) the use of state of the art analysis tools designers; and (3) verifications of theory which might be lacking or inadequate. Summaries of these informative discussions as well as the questions and answers which followed each paper are documented in the proceedings.

**N82-23685\*#** Oregon State Univ., Corvallis. Dept. of Mechanical Engineering.

**AERODYNAMIC POTPOURRI**  
R. E. WILSON /n NASA. Lewis Research Center Wind Turbine Dyn. p 3-7 May 1981 refs  
Avail: NTIS HC A18/MF A01 CSCL 10B

Aerodynamic developments for vertical axis and horizontal axis wind turbines are given that relate to the performance and

aerodynamic loading of these machines. Included are: (1) a fixed wake aerodynamic model of the Darrieus vertical axis wind turbine; (2) experimental results that suggest the existence of a laminar flow Darrieus vertical axis turbine; (3) a simple aerodynamic model for the turbulent windmill/vortex ring state of horizontal axis rotors; and (4) a yawing moment of a rigid hub horizontal axis wind turbine that is related to blade coning. Author

**N82-23686\*#** Toledo Univ., Ohio. Dept. of Mechanical Engineering.

**AERODYNAMIC PERFORMANCE PREDICTION OF HORIZONTAL AXIS WIND TURBINES**

D. R. JENG, T. G. KEITH, and A. ALIAKBARKHANAFJEH /n NASA. Lewis Research Center Wind Turbine Dyn. p 9-18 May 1981 refs  
(Contract NCC3-5)

Avail: NTIS HC A18/MF A01 CSCL 10B

A new method for calculating the aerodynamic performance of horizontal axis wind turbines is described. The method, entitled the helical vortex method, directly calculates the local induced velocity due to helical vortices that originate at the rotor blade. Furthermore, the method does not require a specified circulation distribution. Results of the method are compared to similar results obtained from Wilson PROP code methods as well as to existing experimental data taken from a Mod-O wind turbine. It is shown that results of the proposed method agree well with experimental values of the power output both near cut-in and at rated wind speeds. Further, it is found that the method does not experience some of the numerical difficulties encountered by the PROP code when run at low wind velocities. Author

**N82-23687\*#** Institut de Recherche de l'Hydro-Quebec, Varennes.

**DOUBLE-MULTIPLE STREAMTUBE MODEL FOR DARRIEUS IN TURBINES**

I. PARASCHIVOIU /n NASA. Lewis Research Center Wind Turbine Dyn. p 19-25 May 1981 refs Sponsored in part by IREQ

Avail: NTIS HC A18/MF A01 CSCL 10B

An analytical model is proposed for calculating the rotor performance and aerodynamic blade forces for Darrieus wind turbines with curved blades. The method of analysis uses a multiple-streamtube model, divided into two parts: one modeling the upstream half-cycle of the rotor and the other, the downstream half-cycle. The upwind and downwind components of the induced velocities at each level of the rotor were obtained using the principle of two actuator disks in tandem. Variation of the induced velocities in the two parts of the rotor produces larger forces in the upstream zone and smaller forces in the downstream zone. Comparisons of the overall rotor performance with previous methods and field test data show the important improvement obtained with the present model. The calculations were made using the computer code CARDAA developed at IREQ. The double-multiple streamtube model presented has two major advantages: it requires a much shorter computer time than the three-dimensional vortex model and is more accurate than multiple-streamtube model in predicting the aerodynamic blade loads. Author

**N82-23688\*#** United Technologies Corp., East Hartford, Conn. Aeromechanics Research Section.

**THE UTRC WIND ENERGY CONVERSION SYSTEM PERFORMANCE ANALYSIS FOR HORIZONTAL AXIS WIND TURBINES (WECSPER)**

T. A. EGOLF and A. J. LANDGREBE /n NASA. Lewis Research Center Wind Turbine Dyn. p 27-34 May 1981 refs  
Avail: NTIS HC A18/MF A01 CSCL 10B

The theory for the UTRC Energy Conversion System Performance Analysis (WECSPER) for the prediction of horizontal axis wind turbine performance is presented. Major features of the analysis are the ability to: (1) treat the wind turbine blades as lifting lines with a prescribed wake model; (2) solve for the wake-induced inflow and blade circulation using real nonlinear airfoil data; and (3) iterate internally to obtain a compatible wake transport

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velocity and blade loading solution. This analysis also provides an approximate treatment of wake distortions due to tower shadow or wind shear profiles. Finally, selected results of internal UTRC application of the analysis to existing wind turbines and correlation with limited test data are described. Author

**N82-23689\*#** Young Energy Systems, Dennisport, Mass.  
**THE VELOCITY FIELD OF A SYSTEM OF UNSTEADY CYCLOIDAL VORTICIES**

B. J. YOUNG /in NASA. Lewis Research Center Wind Turbine Dyn. p 35-40 May 1981 refs  
Avail: NTIS HC A18/MF A01 CSCL 10B

An essential difference between two-dimensional and three-dimensional models of cycloidal rotors, the presence of unsteady trailing cycloidal vortices in the wake, was studied. The velocity induced by these vortices is the primary mechanism producing flow retardation for low span/radius ratio, finite blade number rotors. Results of using idealized rigid wake model of finite blade cycloidal rotors to investigate some cycloidal rotor problems are presented. Author

**N82-23691\*#** University of Western Ontario, London. Dept. of Engineering Science.

**ON THE WAKE OF A DARRIEUS TURBINE**

T. E. BASE, P. PHILLIPS, G. ROBERTSON, and E. S. NOWAK /in NASA. Lewis Research Center Wind Turbine Dyn. p 51-66 May 1981 refs

Avail: NTIS HC A18/MF A01 CSCL 10B

The theory and experimental measurements on the aerodynamic decay of a wake from high performance vertical axis wind turbine are discussed. In the initial experimental study, the wake downstream of a model Darrieus rotor, 28 cm diameter and a height of 45.5 cm, was measured in a Boundary Layer Wind Tunnel. The wind turbine was run at the design tip speed ratio of 5.5. It was found that the wake decayed at a slower rate with distance downstream of the turbine, than a wake from a screen with similar troposkein shape and drag force characteristics as the Darrieus rotor. The initial wind tunnel results indicated that the vertical axis wind turbines should be spaced at least forty diameters apart to avoid mutual power depreciation greater than ten per cent. Author

**N82-23692\*#** Sandia Labs., Albuquerque, N. Mex.  
**RECENT DARRIEUS VERTICAL AXIS WIND TURBINE AERODYNAMICAL EXPERIMENTS AT SANDIA NATIONAL LABORATORIES**

P. C. KLIMAS /in NASA. Lewis Research Center Wind Turbine Dyn. p 67-76 May 1981 refs  
(Contract DE-AC04-76DP-00789)

Avail: NTIS HC A18/MF A01 CSCL 10B

Experiments contributing to the understanding of the aerodynamics of airfoils operating in the vertical axis wind turbine (VAWT) environment are described. These experiments are ultimately intended to reduce VAWT cost of energy and increase system reliability. They include chordwise pressure surveys, circumferential blade acceleration surveys, effects of blade camber, pitch and offset, blade blowing, and use of sections designed specifically for VAWT application. Author

**N82-23693\*#** Purdue Univ., Lafayette, Ind.  
**PERFORMANCE OF WIND TURBINES IN A TURBULENT ATMOSPHERE**

R. M. SUNDAR and J. P. SULLIVAN /in NASA. Lewis Research Center Wind Turbine Dyn. p 79-86 May 1981 refs Sponsored in part by DOE

Avail: NTIS HC A18/MF A01 CSCL 10B

The effect of atmospheric turbulence on the power fluctuations of large wind turbines was studied. The significance of spatial non-uniformities of the wind is emphasized. The turbulent wind with correlation in time and space is simulated on the computer by Shinozuka's method. The wind turbulence is modelled according to the Davenport spectrum with an exponential spatial correlation function. The rotor aerodynamics is modelled by simple blade

element theory. Comparison of the spectrum of power output signal between 1-D and 3-D turbulence, shows the significant power fluctuations centered around the blade passage frequency.

Author

**N82-23695\*#** Oregon State Univ., Corvallis. Dept. of Mechanical Engineering.

**WIND TURBULENCE INPUTS FOR HORIZONTAL AXIS WIND TURBINES**

W. E. HOLLEY, R. W. THRESHER, and S. R. LIN /in NASA. Lewis Research Center Wind Turbine Dyn. p 101-112 May 1981 refs

Avail: NTIS HC A18/MF A01 CSCL 10B

Wind turbine response characteristics in the presence of atmospheric turbulence was predicted using two major modeling steps. First, the important atmospheric sources for the force excitations felt by the wind turbine system were identified and characterized. Second, a dynamic model was developed which describes how these excitations are transmitted through the structure and power train. The first modeling step, that of quantifying the important excitations due to the atmospheric turbulence was established. The dynamic modeling of the second step was undertaken separately. Author

**N82-23696\*#** National Aeronautics and Space Administration. Lewis Research Center, Cleveland, Ohio.

**APPLICATIONS OF THE DOE/NASA WIND TURBINE ENGINEERING INFORMATION SYSTEM**

H. E. NEUSTADTER and D. A. SPERA /in its Wind Turbine Dyn. p 113-120 May 1981 refs

Avail: NTIS HC A18/MF A01 CSCL 10B

A statistical analysis of data obtained from the Technology and Engineering Information Systems was made. The systems analyzed consist of the following elements: (1) sensors which measure critical parameters (e.g., wind speed and direction, output power, blade loads and component vibrations); (2) remote multiplexing units (RMUs) on each wind turbine which frequency-modulate, multiplex and transmit sensor outputs; (3) on-site instrumentation to record, process and display the sensor output; and (4) statistical analysis of data. Two examples of the capabilities of these systems are presented. The first illustrates the standardized format for application of statistical analysis to each directly measured parameter. The second shows the use of a model to estimate the variability of the rotor-thrust loading, which is a derived parameter. Author

**N82-23698\*#** DAF Indal Ltd., Mississauga (Ontario).  
**PERFORMANCE TESTING OF A 50 KW VAWT IN A BUILT-UP ENVIRONMENT**

L. A. SCHIENBEIN /in NASA. Lewis Research Center Wind Turbine Dyn. p 129-138 May 1981 refs

Avail: NTIS HC A18/MF A01 CSCL 10B

The results of performance tests of a DAF Indal 50 kW vertical axis wind turbine are presented. Results of limited free stream turbulence and vertical wind shear measurements at the site are also presented. The close agreement between measured and predicted energy outputs, required to verify the wind turbine power output performance relationship, was not attained. A discussion is presented of factors that may have contributed to the lack of better agreement. Author

**N82-23700\*#** Browning Engineering Corp., Hanover, N.H.  
**THE HYDRAULIC WINDMILL**

J. A. BROWING /in NASA. Lewis Research Center Wind Turbine Dyn. p 151-154 May 1981

(Contract DE-FG01-80IR-10320)

Avail: NTIS HC A18/MF A01 CSCL 10B

An hydraulic windmill is described. It pumps pressurized oil from rotor shaft level to the ground where a motor generator produces electricity. Alternatively, the useful output may be heat. Rotor speed is governed by a flow valve. Over pressure, the result of high wind velocity, rotates the tail to move the rotor blades out-of-the-wind. Loss of oil pressure causes a brake to

close as well as to swing the tail to its maximum distance from the rotor plane. Author

**N82-23709\*#** Rockwell International Corp., Canoga Park, Calif. Energy Systems Group.

**EXPERIENCE ON THE USE OF MOSTAB-HFW COMPUTER CODE FOR HORIZONTAL-AXIS WIND TURBINES**

Y. Y. YU /in NASA. Lewis Research Center Wind Turbine Dyn. p 221-223 May 1981 refs

Avail: NTIS HC A18/MF A01 CSCL 10B

Three topics are covered dealing with the frequencies of a rotating beam, the use of the fundamental mode of a uniform cantilever beam, and the analysis of resonance dwell. Immensely high peak loads were generated by the code for resonance dwell indicating further need for including structural damping and for transient analysis capability. The effect of structural damping, newly incorporated in the code, is described. T.M.

**N82-23710\*#** National Aeronautics and Space Administration. Lewis Research Center, Cleveland, Ohio.

**COMPARISON OF UPWIND AND DOWNWIND ROTOR OPERATION OF THE DOE/NASA 100-KW MOD-0 WIND TURBINE**

J. C. GLASGOW, D. R. MILLER, and R. D. CORRIGAN /in its Wind Turbine Dyn. p 225-234 May 1981 refs

Avail: NTIS HC A18/MF A01 CSCL 10B

Tests were conducted on a 38m diameter horizontal axis wind turbine, which had first a rotor downwind of the supporting truss tower and then upwind of the tower. Aside from the placement of the rotor and the direction of rotation of the drive train, the wind turbine was identical for both tests. Three aspects of the test results are compared: rotor blade bending loads, rotor teeter response, and nacelle yaw moments. As a result of the tests, it is shown that while mean flatwise bending moments were unaffected by the placement of the rotor, cyclic flatwise bending tended to increase with wind speed for the downwind rotor while remaining somewhat uniform with wind speed for the upwind rotor, reflecting the effects of increased flow disturbance for downwind rotor. Rotor teeter response was not significantly affected by the rotor location relative to the tower, but appears to reflect reduced teeter stability near rated wind speed for both configurations. Teeter stability appears to return above rated wind speed, however. Nacelle yaw moments are higher for the upwind rotor but do not indicate significant design problems for either configuration. T.M.

**N82-23711\*#** National Aeronautics and Space Administration. Lewis Research Center, Cleveland, Ohio.

**A REVIEW OF RESONANCE RESPONSE IN LARGE HORIZONTAL-AXIS WIND TURBINES**

T. L. SULLIVAN /in its Wind Turbine Dyn. p 237-244 May 1981 refs

Avail: NTIS HC A18/MF A01 CSCL 10B

Field operation of the Mod-0 and Mod-1 wind turbines is described. Operational experience shows that 1 per rev excitation exists in the drive train, high aerodynamic damping prevents resonance response of the blade flatwise modes, and teetering the hub substantially reduces the chordwise blade response to odd harmonic excitation. These results can be used by designer as a guide to system frequency placement. In addition it is found that present analytical techniques can accurately predict wind turbine natural frequencies. T.M.

**N82-23712\*#** Rockwell International Corp., Golden, Colo. Energy Systems Group.

**SWECs TOWER DYNAMICS ANALYSIS METHODS AND RESULTS**

A. D. WRIGHT, J. H. SEXTON, C. P. BUTTERFIELD, and R. M. THRESHER (Oregon State Univ., Corvallis) /in NASA. Lewis Research Center Wind Turbine Dyn. p 245-253 May 1981 refs

Avail: NTIS HC A18/MF A01 CSCL 10B

Several different tower dynamics analysis methods and computer codes were used to determine the natural frequencies

and mode shapes of both guyed and freestanding wind turbine towers. These analysis methods are described and the results for two types of towers, a guyed tower and a freestanding tower, are shown. The advantages and disadvantages in the use of and the accuracy of each method are also described. T.M.

**N82-23715\*#** Ventus Energy Corp., La Crescenta, Calif.

**PASSIVE CYCLIC PITCH CONTROL FOR HORIZONTAL AXIS WIND TURBINES**

G. W. BOTTRELL /in NASA. Lewis Research Center Wind Turbine Dyn. p 271-275 May 1981 refs

Avail: NTIS HC A18/MF A01 CSCL 10B

A flexible rotor concept, called the balanced pitch rotor, is described. The system provides passive adjustment of cyclic pitch in response to unbalanced pitching moments across the rotor disk. Various applications are described and performance predictions are made for wind shear and cross wind operating conditions. Comparisons with the teetered hub are made and significant cost savings are predicted. T.M.

**N82-23719\*#** Sandia Labs., Albuquerque, N. Mex.

**VERTICAL AXIS WIND TURBINE DRIVE TRAIN TRANSIENT DYNAMICS**

D. B. CLAUSS and T. G. CARNE /in NASA. Lewis Research Center Wind Turbine Dyn. p 305-314 May 1982 refs

Avail: NTIS HC A18/MF A01 CSCL 10B

Start up of a vertical axis wind turbine causes transient torque oscillations in the drive train with peak torques which may be over two and one half times the rated torque of the turbine. A computer code, based on a lumped parameter model of the drive train, was developed and tested for the low cost 17 meter turbine; the results show excellent agreement with field data. The code was used to predict the effect of a slip clutch on transient torque oscillations. It was demonstrated that a slip clutch located between the motor and brake can reduce peak torques by thirty eight percent. T.M.

**N82-23720\*#** Power Technologies, Inc., Schenectady, N. Y.

**DYNAMICS AND STABILITY OF WIND TURBINE GENERATORS**

E. N. HINRICHSSEN and P. J. NOLAN /in NASA. Lewis Research Center Wind Turbine Dyn. p 315-324 May 1981 refs

Avail: NTIS HC A18/MF A01 CSCL 10B

Synchronous and induction generators are considered. A comparison is made between wind turbines, steam, and hydro units. The unusual phenomena associated with wind turbines are emphasized. The general control requirements are discussed, as well as various schemes for torsional damping such as speed sensitive stabilizer and blade pitch control. Integration between adjacent wind turbines in a wind farm is also considered. T.M.

**N82-23721\*#** Kaman Aerospace Corp., Bloomfield, Conn.

**KAMAN 40 KW WIND TURBINE GENERATOR - CONTROL SYSTEM DYNAMICS**

R. PERLEY /in NASA. Lewis Research Center Wind Turbine Dyn. p 325-332 May 1981 refs

Avail: NTIS HC A18/MF A01 CSCL 10B

The generator design incorporates an induction generator for application where a utility line is present and a synchronous generator for standalone applications. A combination of feed forward and feedback control is used to achieve synchronous speed prior to connecting the generator to the load, and to control the power level once the generator is connected. The dynamics of the drive train affect several aspects of the system operation. These were analyzed to arrive at the required shaft stiffness. The rotor parameters that affect the stability of the feedback control loop vary considerably over the wind speed range encountered. Therefore, the controller gain was made a function of wind speed in order to maintain consistent operation over the whole wind speed range. The velocity requirement for the pitch control mechanism is related to the nature of the wind gusts to be encountered, the dynamics of the system, and the acceptable power fluctuations and generator dropout rate. A model was

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developed that allows the probable dropout rate to be determined from a statistical model of wind gusts and the various system parameters, including the acceptable power fluctuation. T.M.

**N82-23722\*#** New Mexico Univ., Albuquerque. Engineering Research Inst.

### **AUTOMATIC CONTROL ALGORITHM EFFECTS ON ENERGY PRODUCTION**

G. M. MCNERNEY /in NASA. Lewis Research Center Wind Turbine Dyn. p 333-342 May 1981 refs  
Avail: NTIS HC A18/MF A01 CSCL 10B

A computer model was developed using actual wind time series and turbine performance data to simulate the power produced by the Sandia 17-m VAWT operating in automatic control. The model was used to investigate the influence of starting algorithms on annual energy production. The results indicate that, depending on turbine and local wind characteristics, a bad choice of a control algorithm can significantly reduce overall energy production. The model can be used to select control algorithms and threshold parameters that maximize long term energy production. The results from local site and turbine characteristics were generalized to obtain general guidelines for control algorithm design. T.M.

**N82-23723\*#** Michigan State Univ., East Lansing.

### **EFFECT OF WIND TURBINE GENERATOR MODEL AND SITING ON WIND POWER CHANGES OUT OF LARGE WECS ARRAYS**

R. A. SCHLEUTER, G. L. PARK, M. LOTFALIAN, J. DORSEY, and H. SHAYANFAR /in NASA. Lewis Research Center Wind Turbine Dyn. p 343-352 May 1981 refs  
Avail: NTIS HC A18/MF A01 CSCL 10B

Methods of reducing the WECS generation change through selection of the wind turbine model for each site, selection of an appropriate siting configuration, and wind array controls are discussed. An analysis of wind generation change from an echelon and a farm for passage of a thunderstorm is presented. Reduction of the wind generation change over ten minutes is shown to reduce the increase in spinning reserve, unloadable generation and load following requirements on unit commitment when significant WECS generation is present and the farm penetration constraint is satisfied. Controls on the blade pitch angle of all wind turbines in an array or a battery control are shown to reduce both the wind generation change out of an array and the effective farm penetration in anticipation of a storm so that the farm penetration constraint may be satisfied. T.M.

**N82-23724\*#** National Aeronautics and Space Administration. Langley Research Center, Hampton, Va.

### **MEASURED AND CALCULATED CHARACTERISTICS OF WIND TURBINE NOISE**

G. C. GREENE /in NASA. Lewis Research Center Wind Turbine Dyn. p 355-362 May 1981 refs  
Avail: NTIS HC A18/MF A01 CSCL 10B

The results of an analytical and experimental investigation of wind turbine noise are presented. Noise calculations indicate that for configurations with the rotor downwind of the support tower, the primary source of noise is the rapid change in rotor loadings which occurs as the rotor passes through the tower wake. Noise measurements are presented for solid and truss type tower models with both upwind and downwind rotors. Upwind rotor configurations are shown to be significantly quieter than downwind configurations. The model data suggest that averaged noise measurements and noise calculations based on averaged tower wake characteristics may not accurately represent the impulsive noise characteristics of downwind rotor configurations. Author

**N82-23725\*#** Wichita State Univ., Kans. Wind Energy Lab.

### **DYNAMICS OF WAKES DOWNSTREAM OF WIND TURBINE TOWERS**

M. H. SNYDER and W. H. WENTZ, JR. /in NASA. Lewis Research Center Wind Turbine Dyn. p 369-373 May 1981 refs  
Avail: NTIS HC A18/MF A01 CSCL 10B

The near field wakes downstream of circular cylinders and of 12 sided cylinders were surveyed in a wind tunnel. Local velocity

and velocity deficit diagrams are presented. The variation of turbulence in the wake was surveyed and the frequency of the periodic component of wake motion was determined. Differences between wakes of circular cylinders and of 12 sided cylinders are discussed. Also effects of strakes, orientation of the 12 sided cylinders, and rounding of the corners are noted. Author

**N82-23726\*#** Midwest Research Inst., Golden, Colo. Wind Energy Branch.

### **ACOUSTIC NOISE GENERATION BY THE DOE/NASA MOD-1 WIND TURBINE**

N. D. KELLEY /in NASA. Lewis Research Center Wind Turbine Dyn. p 375-387 May 1981 refs Sponsored in part by DOE  
Avail: NTIS HC A18/MF A01 CSCL 10B

The results of a series of measurements taken over the past year of the acoustic emissions from the DOE/NASA MOD-1 Wind Turbine show the maximum acoustic energy is concentrated in the low frequency range, often below 100 Hz. The temporal as well as the frequency characteristics of the turbine sounds have been shown to be important since the MOD-1 is capable of radiating both coherent and incoherent noise. The coherent sounds are usually impulsive and are manifested in an averaged frequency domain plot as large numbers of discrete energy bands extending from the blade passage frequency to beyond 50 Hz on occasion. It is these impulsive sounds which are identified as the principal source of the annoyance to a dozen families living within 3 km of the turbine. The source of the coherent noise appears to be the rapid, unsteady blade loads encountered as the blade passes through the wake of the tower structure. Annoying levels are occasionally reached at nearby homes due to the interaction of the low frequency, high energy peaks in the acoustic impulses and the structural modes of the homes as well as by direct radiation outdoors. The peak levels of these impulses can be enhanced or subdued through complete propagation. Author

**N82-23727\*#** General Electric Co., Schenectady, N. Y.

### **GE MOD-1 NOISE STUDY**

R. J. WELLS /in NASA. Lewis Research Center Wind Turbine Dyn. p 389-395 May 1981 refs  
Avail: NTIS HC A18/MF A01 CSCL 10B

Noise studies of the MOD-1 Wind Turbine Generator are summarized, and a simple mathematical noise is presented which is adequate to correlate the sound levels found near the machine. A simple acoustic measure is suggested for use in evaluating far field sound levels. Use of this measure as input to a currently available sound complaint prediction program is discussed. Results of a recent statistical survey relative to the far field variation of this acoustic measure because of atmospheric effects are described. Author

**N82-23728\*#** Pennsylvania State Univ., University Park. Dept. of Meteorology.

### **ENHANCEMENT OF FAR FIELD SOUND LEVELS BY REFRACTIVE FOCUSING**

D. W. THOMSON and S. D. ROTH /in NASA. Lewis Research Center Wind Turbine Dyn. p 397-400 May 1981 refs  
Avail: NTIS HC A18/MF A01 CSCL 10B

The enhancement of sound pressure levels resulting from refractive focusing was calculated for meteorological conditions representative of those observed at the MOD-1 site near Boone, N.C. The results show that 10 to 20dB enhancements can occur over ranges of several hundred meters. Localized enhancements in excess of 20dB can occur but will probably be of limited duration as a consequence of normal temporally varying meteorological conditions. Author

**N82-23729\*#** Massachusetts Inst. of Tech., Cambridge.  
**PREDICTION OF LOW FREQUENCY AND IMPULSIVE SOUND RADIATION FROM HORIZONTAL AXIS WIND TURBINES**  
 R. MARTINEZ, S. E. WIDNALL, and W. L. HARRIS /in NASA. Lewis Research Center Wind Turbine Dyn. p 401-409 May 1981 refs Sponsored in part by Midwest Research Inst.  
 Avail: NTIS HC A18/MF A01 CSCL 10B

Theoretical models to predict the radiation of low frequency and impulsive sound from horizontal axis wind turbines due to three sources: (1) steady blade loads; (2) unsteady blade loads due to operation in a ground shear; (3) unsteady loads felt by the blades as they cross the tower wake. These models are then used to predict the acoustic output of MOD-1, the large wind turbine operated near Boone, N.C. Predicted acoustic time signals are compared to those actually measured near MOD-1 and good agreement is obtained. Author

**N82-23730\*#** National Aeronautics and Space Administration. Lewis Research Center, Cleveland, Ohio.  
**THE NASA-LERC WIND TURBINE SOUND PREDICTION CODE**  
 L. A. VITERNA /in its Wind Turbine Dyn. p 411-418 May 1981 refs  
 Avail: NTIS HC A18/MF A01 CSCL 10B

Since regular operation of the DOE/NASA MOD-1 wind turbine began in October 1979 about 10 nearby households have complained of noise from the machine. Development of the NASA-LeRC with turbine sound prediction code began in May 1980 as part of an effort to understand and reduce the noise generated by MOD-1. Tone sound levels predicted with this code are in generally good agreement with measured data taken in the vicinity MOD-1 wind turbine (less than 2 rotor diameters). Comparison in the far field indicates that propagation effects due to terrain and atmospheric conditions may be amplifying the actual sound levels by about 6 dB. Parametric analysis using the code has shown that the predominant contributions to MOD-1 rotor noise are: (1) the velocity deficit in the wake of the support tower; (2) the high rotor speed; and (3) off column operation. Author

**N82-23731\*#** Boeing Vertol Co., Philadelphia, Pa.  
**NOISE GENERATION OF UPWIND MOTOR WIND TURBINE GENERATORS**  
 R. H. SPENCER /in NASA. Lewis Research Center Wind Turbine Dyn. p 419-423 May 1981 refs  
 Avail: NTIS HC A18/MF A01 CSCL 10B

Noise sources of wind turbines with rotors upstream of the support structure are discussed along with methodology for sound level prediction. Estimated noise levels for the MOD-2 wind turbine are presented operating in both the upwind and downwind configurations. Results indicate that upwind rotor configurations may be advantageous from an acoustical standpoint. Author

**N82-23732\*#** Hamilton Standard, Windsor Locks, Conn.  
**DOWNWIND ROTOR HORIZONTAL AXIS WIND TURBINE NOISE PREDICTION**  
 F. B. METZGER and R. J. KLATTE /in NASA. Lewis Research Center Wind Turbine Dyn. p 425-430 May 1981 refs Sponsored in part by NASA. Langley Research Center, Midwest Research Inst., and Wichita State Univ.  
 Avail: NTIS HC A18/MF A01 CSCL 10B

NASA and industry are currently cooperating in the conduct of extensive experimental and analytical studies to understand and predict the noise of large, horizontal axis wind turbines. This effort consists of (1) obtaining high quality noise data under well controlled and documented test conditions, (2) establishing the annoyance criteria for impulse noise of the type generated by horizontal axis wind turbines with rotors downwind of the support tower, (3) defining the wake characteristics downwind of the axial location of the plane of rotation, (4) comparing predictions with measurements made by use of wake data, and (5) comparing predictions with annoyance criteria. The status of work by Hamilton Standard in the above areas which was done in support of the cooperative NASA and industry studies is briefly summarized. Author

**N82-23733\*#** National Aeronautics and Space Administration. Langley Research Center, Hampton, Va.  
**WIND TURBINE ACOUSTIC STANDARDS**  
 D. G. STEPHENS, K. P. SHEPHERD (Bionetics Corp., Hampton, Va.), and F. GROSVELD (Bionetics Corp., Hampton, Va.) /in NASA Lewis Research Center Wind Turbine Dyn. p 431-435 May 1981 refs  
 Avail: NTIS HC A18/MF A01 CSCL 10B

A program is being conducted to develop noise standards for wind turbines which minimize annoyance and which can be used to design specifications. The approach consists of presenting wind turbine noise stimuli to test subjects in a laboratory listening chamber. The responses of the subjects are recorded for a range of stimuli which encompass the designs, operating conditions, and ambient noise levels of current and future installations. Results to date have established the threshold of detectability for a range of impulsive stimuli of the type associated with blade/tower wake interactions. The status of the ongoing psychoacoustic tests, the subjective data, and the approach to the development of acoustic criteria/standards are described. Author

**N82-23749#** JBF Scientific Corp., Wilmington, Mass.  
**SMALL-WIND-SYSTEMS APPLICATION ANALYSIS. TECHNICAL REPORT AND EXECUTIVE SUMMARY**  
 Jun. 1981 384 p refs Sponsored in part by Rockwell International Corp., Golden, Colo.  
 (Contract DE-AC04-76DP-03533)  
 (DE82-003748; RFP-3147/2) Avail: NTIS HC A17/MF A01

A small wind energy conversion systems (SWECS) analysis was conducted to estimate the potential market for SWECS, or wind machines smaller than 100 kW for five selected applications. The goals were to aid manufacturers in attaining financing by convincing venture capital investors of the potential of SWECS and to aid government planners in allocating R and D expenditures that will effectively advance SWECS commercialization. Based on these goals, the study: (1) provides a basis for assisting the DOE in planning R and D programs that will advance the state of SWECS industry; (2) quantifies estimates of market size vs. installed system cost to enable industry to plan expansion of capacity and product lines; (3) identifies marketing strategies for industry to use in attaining financing from investors and in achieving sales goals; and (4) provides DOE with data that will assist in determining actions, incentives, and/or legislation required to achieve a commercially viable SWECS industry. The five applications were selected through an initial screening and priority-ranking analysis. The year of analysis was 1985, but all dollar amounts, such as fuel costs, are expressed in 1980 dollars. The five SWECS applications investigated were farm residences, non-farm residences, rural electric cooperatives, feed grinders, and remote communities. DOE

**N82-23775#** National Aerospace Lab., Amsterdam (Netherlands). Fluid Dynamics Div.  
**GENERAL INTRODUCTION TO WIND ENERGY CONVERSION**  
 O. DEVRIES Apr. 1981 128 p refs Presented at Von Karman Inst. for Fluid Dyn. Lecture Series No. 9 on Wind Energy Conversion Devices, Rhode-Saint-Genese, Belgium, 1-5 Jun. 1981  
 (NLR-MP-81014-U) Avail: NTIS HC A07/MF A01

Wind turbine and wind concentrator concepts are reviewed and the aerodynamic characteristics of wind turbines are discussed. The parameters which determine choice of conversion scheme, e.g., wind data, turbine control, conversion system, structural, dynamic and cost aspects, and environmental impediments, are considered. Design criteria are surveyed and the desirability of formulating building codes for wind energy conversion projects is stressed. Author (ESA)

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**N82-24079\*#** National Aeronautics and Space Administration. Pasadena Office, Calif.

### **MHD ELECTRICAL GENERATOR Patent Application**

D. J. FITZGERALD, inventor (to NASA) (JPL, California Inst. of Technology, Pasadena) 14 Feb. 1982 13 p  
(Contract NAS7-100)

(NASA-CASE-NPO-15399-1; US-PATENT-APPL-SN-330612)

Avail: NTIS HC A02/MF A01 CSCL 20I

An MHD (magnetohydrodynamic) electric generator is provided which is of high efficiency and which can operate in a closed cycle with minimal moving parts for unattended applications. The generator includes a porous tungsten element heated by a heat source and a system for passing primarily pure cesium vapor into the porous element, to produce contact ionization of the cesium with a higher percentage of ions than can be sustained. The highly ionized cesium vapor, and corresponding numbers of electrons from the tungsten element, recombine to produce a much higher temperature as the cesium flows through a tube past an MHD converter that generates electricity, and into a cool end of the tube where the cesium is cooled to a liquid temperature. The liquid can be recirculated by passing it through capillary passages extending towards the location where cesium vapor enters the porous tungsten element. NASA

**N82-24289\*#** AiResearch Mfg. Co., Phoenix, Ariz.

### **STUDY OF REACTOR BRAYTON POWER SYSTEMS FOR NUCLEAR ELECTRIC SPACECRAFT**

28 Sep. 1979 169 p refs Prepared for JPL, Pasadena, Calif. Original contains color illustrations

(Contract JPL-955008)

(NASA-CR-168942; NAS 1.26:168942; AIRESEARCH-31-3321)

Avail: NTIS HC A08/MF A01 CSCL 21C

The feasibility of using Brayton power systems for nuclear electric spacecraft was investigated. The primary performance parameters of systems mass and radiator area were determined for systems from 100 to 1000 kW sub e. Mathematical models of all system components were used to determine masses and volumes. Two completely independent systems provide propulsion power so that no single-point failure can jeopardize a mission. The waste heat radiators utilize armored heat pipes to limit meteorite puncture. The armor thickness was statistically determined to achieve the required probability of survival. A 400 kW sub e reference system received primary attention as required by the contract. The components of this system were defined and a conceptual layout was developed with encouraging results. An arrangement with redundant Brayton power systems having a 1500 K (2240 F) turbine inlet temperature was shown to be compatible with the dimensions of the space shuttle orbiter payload bay. B.W.

**N82-24421\*** National Aeronautics and Space Administration. Goddard Space Flight Center, Greenbelt, Md.

### **LINEAR MAGNETIC MOTOR/GENERATOR Patent**

P. A. STUDER, inventor (to NASA) 9 Feb. 1982 13 p Filed 7 Feb. 1980 Supersedes N80-19424 (18 - 10, p 1287)

(NASA-CASE-GSC-12518-1; US-PATENT-4,315,197;

US-PATENT-APPL-SN-119336; US-PATENT-CLASS-318-135;

US-PATENT-CLASS-335-229; US-PATENT-CLASS-335-266;

US-PATENT-CLASS-310-12) Avail: US Patent and Trademark Office CSCL 09A

A linear magnetic motor/generator is disclosed which uses magnetic flux to provide mechanical motion or electrical energy. The linear magnetic motor/generator includes an axially movable actuator mechanism. A permanent magnet mechanism defines a first magnetic flux path which passes through a first end portion of the actuator mechanism. Another permanent magnet mechanism defines a second magnetic flux path which passes through a second end portion of the actuator mechanism. A drive coil defines a third magnetic flux path passing through a third central portion of the actuator mechanism. A drive coil selectively adds magnetic flux to and subtracts magnetic flux from magnetic flux flowing in the first and second magnetic flux path.

Official Gazette of the U.S. Patent and Trademark Office

**N82-24424\*#** Department of Energy, Washington, D. C.

### **DEVELOPMENT OF A DUAL-FIELD HETEROPOPLAR POWER CONVERTER**

D. B. EISENHAURE, B. JOHNSON, T. E. BLIAMPTIS, and E. STGEORGE Aug. 1981 68 p refs

(Contract NAS3-20817; DE-AI01-77CS-1044)

(NASA-CR-165168; NAS 1.26:165168; R-1489) Avail: NTIS HC A04/MF A01 CSCL 10B

The design and testing of a 400 watt, dual phase, dual rotor, field modulated inductor alternator is described. The system is designed for use as a flywheel to ac utility line or flywheel to dc bus (electric vehicle) power converter. The machine is unique in that it uses dual rotors and separately controlled fields to produce output current and voltage which are in phase with each other. Having the voltage and current in phase allows the power electronics to be made of simple low cost components. Based on analytical predictions and experimental results, development of a complete 22 kilowatt (30 Hp) power conversion system is recommended. This system would include power electronics and controls and would replace the inductor alternator with an improved electromagnetic conversion system. Author

**N82-24425\*#** Eaton Engineering and Research Center, Southfield, Mich.

### **STRAIGHT AND CHOPPED DC PERFORMANCE DATA FOR A GENERAL ELECTRIC 5BY436A1 DC SHUNT MOTOR WITH A GENERAL ELECTRIC EV-1 CONTROLLER Final Report**

P. C. EDIE Oct. 1981 58 p

(Contract DEN3-123; DE-AI01-77CS-51044)

(NASA-CR-165507; DOE/NASA/0123-4; NAS 1.26:165507;

ERC-TR-8186) Avail: NTIS HC A04/MF A01 CSCL 09C

Both straight and chopped dc motor performance data for a General Electric 5BY436A1 motor with a General Electric EV-1 controller is presented in tabular and graphical formats. Effects of motor temperature and operating voltage are also shown. The maximum motor efficiency is approximately 85% at low operating temperatures in the straight dc mode. Chopper efficiency can be assumed to be 95% under all operating conditions. For equal speeds, the motor operated in the chopped mode develops slightly more torque and draws more current than it does in the straight mode. Author

**N82-24461#** North Carolina State Univ., Raleigh. Dept. of Mechanical and Aerospace Engineering.

### **EARTH-COUPLED HEAT PUMP Final Report, 1 Jul. 1979 - 30 Sep. 1980**

J. A. EDWARDS 30 Aug. 1981 41 p refs

(DE82-900583; NCEI-0033) Avail: NTIS HC A03/MF A01

The object of the research work was to demonstrate that a water source heat pump could be used with an earth-coupled heat exchanger which was buried in an absorption field of a domestic sewage disposal system to provide the heating and cooling requirements for residential use in an energy efficient fashion. The system consists of a 3 ton heat pump (nominal rating of 34,000 Btu/hr), a closed-loop heat exchanger which was fabricated from 200 feet of 2 inch diameter cast iron soil pipe, and a calorimeter house which had heat transmission characteristics similar to a 100 sq ft house. The earth-coupled heat exchanger was connected to the water side heat exchanger of the heat pump. Water was circulated through the heat exchanger coil in the earth and through the water side heat exchanger of the heat pump. The earth served as the energy source (for heating) or sink (for cooling) for the heat pump. DOE

**N82-24639\*** National Aeronautics and Space Administration. Marshall Space Flight Center, Huntsville, Ala.

**AMPLIFIED WIND TURBINE APPARATUS Patent**

L. A. HEIN and W. N. MYERS, inventors (to NASA) 5 Jan. 1982 8 p Filed 12 Mar. 1980 Supersedes N80-21831 (18 - 12, p 1597)

(NASA-CASE-MFS-23830-1; US-PATENT-4,309,146; US-PATENT-APPL-SN-129780; US-PATENT-CLASS-415-2R; US-PATENT-CLASS-415-DIG.8) Avail: US Patent and Trademark Office CSCL 10B

An invention related to the utilization of wind energy and increasing the effects thereof for power generation is described. Amplified wind turbine apparatus is disclosed wherein ambient inlet air is prerotated in a first air rotation chamber having a high pressure profile increasing the turbulence and Reynolds number thereof. A second rotation chamber adjacent and downstream of the turbine has a low pressure core profile whereby flow across the turbine is accelerated and thereafter exits the turbine apparatus through a draft anti-interference device. Interference with ambient winds at the outlet of the turbine apparatus is thus eliminated. Pivotal vanes controlled in response to prevailing wind direction admit air to the chambers and aid in imparting rotation. A central core may be utilized for creating the desired pressure profile in the chamber.

M.D.K.

**N82-24701#** Brookhaven National Lab., Upton, N. Y.  
**IMPROVED ALKALINE HYDROGEN/AIR FUEL CELLS FOR TRANSPORTATION APPLICATIONS**

S. SRINIVASAN, J. MCBREEN, G. KISSEL, K. V. KORDESCH, F. KULESA, E. J. TAYLOR, and E. GANNON /in Courtesy Associates, Inc. Proc. of the DOE Thermal and Chem. Storage Ann. Contractor's Rev. Meeting p 188-192 Mar. 1981 refs Avail: NTIS HC A16/MF A01

The improvement of alkaline air electrodes for air depolarized chlor/alkali cells is discussed. Some of these electrodes were evaluated in alkaline hydrogen/air fuel cells. In initial tests with 289 sq cm electrodes, power densities of 100 mW/sq cm were obtained at 0.65 V. Further improvements in the air electrode flow field yielded power densities of 126 mW/sq cm at 0.65 V at an operating temperature of 70 C. The 289 sq cm cells were units in a 16 cell 0.5 kW module. This module yielded similar power densities and its power/weight and power/volume are considered as a building block for a fuel cell power plant in a fuel cell/battery hybrid vehicle.

E.A.K.

**N82-24707#** New York State Energy Research and Development Authority, Albany.

**HYDROPOWERED ELECTROLYSIS IN NEW YORK STATE**

P. D. MALTHUSA and R. A. WILEY /in Courtesy Associates, Inc. Proc. of the DOE Thermal and Chem. Storage Ann. Contractor's Rev. Meeting p 214-217 Mar. 1981 refs Avail: NTIS HC A16/MF A01

An inventory of New York State's hydropower potential located more than 1,000 sites with dams in the state which could be refurbished for power production. It is estimated that these facilities can be made to generate 3.8 billion kilowatt hours of (firm) electrical power per annum. It is found that the use of excess power to operate an advanced technology solid polymer electrolyzer produces research grade hydrogen whose kilowatt hour equivalent value is more than 10 times greater than that of dumped electrical energy.

E.A.K.

**N82-24981#** Stanford Univ., Calif. Dept. of Mechanical Engineering.

**AXIAL FIELD LIMITATIONS IN MHD GENERATORS. PART 2: ANALYTICAL INVESTIGATION AND COMPARISON WITH EXPERIMENTS**

W. UNKEL and C. H. KRUGER Jan. 1981 32 p refs Backup document for AIAA Synoptic. 'Analytical Investigation of Axial Field Limitations in MHD Generators', scheduled for publication in Journal of Energy in Jan. - Feb. 1983

(LOG-E763) Avail: NTIS HC A03/MF A01

A detailed fluid and electrical model was developed and used to predict the prebreakdown and incipient breakdown characteristics for a simplified configuration. The model shows that an electro-thermal instability, in either the plasma or the interelectrode insulator, was responsible for the breakdown; the predicted values of the threshold voltage, below which breakdown would not occur, were comparable to the experimental values. Detailed comparison of theory and experiment, however, indicates only moderately good agreement, even for the relatively sophisticated model used. Nevertheless, the model can be used to predict the trends of threshold voltage with the channel parameters. Breakdown modeling of the full generator configuration was limited to a coarse electrical solution to simulate the effect of single or multiple breakdowns on the behavior of the surrounding gaps; moderate success was achieved with the model. Author

**N82-25636\*#** National Aeronautics and Space Administration. Lewis Research Center, Cleveland, Ohio.

**IMPACT OF UNIFORM ELECTRODE CURRENT DISTRIBUTION ON ETF**

D. J. BENTS 1982 10 p refs Presented at the 20th Aerospace Sci. Meeting, Orlando, Fla., 11-14 Jan 1982 (Contract DE-AI01-77ET-10769)

(NASA-TM-82875; E-1044; NAS 1.15:82875;

DOE/NASA/10769-24) Avail: NTIS HC A02/MF A01 CSCL 10A

The design impacts on the ETF electrode consolidation network associated with uniform channel electrode current distribution are examined and the alternate consolidation design which occur are presented compared to the baseline (non-uniform current) design with respect to performance, and hardware requirements. A rational basis is given for comparing the requirements for the different designs and the savings that result from uniform current distribution. Performance and cost impacts upon the combined cycle plant are discussed. Author

**N82-25961\*#** National Aeronautics and Space Administration. Lewis Research Center, Cleveland, Ohio.

**RESULTS AND COMPARISON OF HALL AND DW DUCT EXPERIMENTS**

J. M. SMITH and J. L. MORGAN 1982 10 p refs Proposed for presentation at the 20th Symp. on Eng. Aspects of Magnetohydrodyn., Los Angeles, 14-16 Jun. 1982

(Contract DE-AI01-77ET-10769)

(NASA-TM-82864; DOE/NASA/10769-25; E-1233; NAS

1.15:82864) Avail: NTIS HC A02/MF A01 CSCL 20I

Experimental data from recent tests of a 45 deg diagonal wall duct are presented and compared with the results of a similar Hall duct. It is shown that while the peak power density of the two devices is approximately equal that the diagonal wall duct produces greater total power output due to its ability to better utilize the available magnetic field. Author

**N82-25981#** Los Alamos Scientific Lab., N. Mex.

**MODULAR STELLARATOR FUSION REACTOR CONCEPT**

R. L. MILLER and R. A. KRAKOWSKI Aug. 1981 161 p refs (Contract W-7405-ENG-36)

(DE82-001883; LA-8978-MS) Avail: NTIS HC A08/MF A01

A steady-state ignited, DT-fueled, magnetic fusion reactor is proposed for use as a central electric-power station. The MSR concept combines the physics of the classic stellarator confinement topology with an innovative, modular-coil design. Parametric tradeoff calculations are described, leading to the selection of an

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interim design point for a 4-GWt plant based on Alcator transport scaling and an average beta value of 0.04 in an  $1 = 2$  system with a plasma aspect ratio of 11. The physical basis of the design point is described together with supporting magnetics, coil-force, and stress computations. T.M.

**N82-25984#** Los Alamos Scientific Lab., N. Mex.  
**ELMO BUMPY TORUS REACTOR AND POWER PLANT: CONCEPTUAL DESIGN STUDY**

C. G. BATHKE, D. J. DUDZIAK, R. A. KRAKOWSKI, W. B. ARD, D. A. BOWERS, J. W. DAVIS, D. A. DEFREECE, D. E. DRIEMEYER, R. E. JUHALA, R. J. KASHUBA et al. Aug. 1981 902 p refs Prepared in cooperation with McDonnell Douglas Astronautics Co., St. Louis, Parsons (Ralph M.) Co., Pasadena, Calif., General Dynamics Convair, San Diego, Calif., and JAYCOR, San Diego, Calif.

(Contract W-7405-ENG-36)  
(DE82-002437; LA-8882-MS) Avail: NTIS HC A99/MF A01

A complete power plant design of a 1200-MWe ELMO Bumpy Torus Reactor (EBTR) is presented. An emphasis is placed on those features that are unique to the EBT confinement concept, with subsystems and balance-of-plant items that are more generic to magnetic fusion being adapted from past, more extensive Tokamak reactor designs. Similar to the latter Tokamak studies, this conceptual EBTR design also emphasizes the use of conventional or near state-of-the-art engineering technology and materials. An emphasis is also placed on system accessibility, reliability, and maintainability, as these crucial and desirable characteristics relate to the unique high-aspect-ratio configuration of EBTRs. Equal and strong emphasis is given to physics, engineering/technology, and costing/economics components of this design effort. Parametric optimizations and sensitivity studies, using cost-of-electricity as an object function, are reported. Based on these results, the direction for future improvement on an already attractive reactor design is identified. DOE

**N82-26678\*#** National Aeronautics and Space Administration.  
Lewis Research Center, Cleveland, Ohio.

**MULTIROLLER TRACTION DRIVE SPEED REDUCER: EVALUATION FOR AUTOMOTIVE GAS TURBINE ENGINE**

D. A. ROHN, N. E. ANDERSON, and S. H. LOEWENTHAL Jun. 1982 24 p refs Prepared in cooperation with Army Aviation Research and Development Command, Cleveland, Ohio (NASA-TP-2027; E-1002; NAS 1.60:2027; AVRADCOM-TR-81-C-11) Avail: NTIS HC A02/MF A01 CSCL 20A

Tests were conducted on a nominal 14:1 fixed-ratio Nasvytis multiroller traction drive retrofitted as the speed reducer in an automotive gas turbine engine. Power turbine speeds of 45,000 rpm and a drive output power of 102 kW (137 hp) were reached. The drive operated under both variable roller loading (proportional to torque) and fixed roller loading (automatic loading mechanism locked). The drive operated smoothly and efficiently as the engine speed reducer. Engine specific fuel consumption with the traction speed reducer was comparable to that with the original helical gearset. Author

**N82-26694#** Ingersoll-Rand Research, Inc., Princeton, N. J.  
**FEASIBILITY OF USING LARGE VERTICAL PUMPS AS TURBINES FOR SMALL SCALE HYDROPOWER Final Technical Report**

P. COOPER and R. WORTHEN 1981 229 p refs (Contract DE-AC07-8010-12160)  
(DE82-004267; DOE/ID-12160/T1) Avail: NTIS HC A11/MF A01

The economic and technical feasibility of operating pumps as turbines in small scale hydropower plants was established. The economics were competitive, and turbine efficiencies of 87% were obtained in actual tests. DOE

**N82-26790\*#** National Aeronautics and Space Administration.  
Lewis Research Center, Cleveland, Ohio.

**OPTIMIZATION OF THE OXIDANT SUPPLY SYSTEM FOR COMBINED CYCLE MHD POWER PLANTS**

A. J. JUHASZ 1982 14 p refs Presented at the 20th Symp. on the Eng. Aspects of Magnetohydrodyn., Irvine, Calif., 14-16 Jun. 1981

(Contract DE-AI01-77ET-10769)  
(NASA-TM-82909; E-1294; DOE/NASA/10769-27; NAS 1.15:82909) Avail: NTIS HC A02/MF A01

An in-depth study was conducted to determine what, if any, improvements could be made on the oxidant supply system for combined cycle MHD power plants which could be reflected in higher thermal efficiency and a reduction in the cost of electricity, COE. A systematic analysis of air separation process variations which showed that the specific energy consumption could be minimized when the product stream oxygen concentration is about 70 mole percent was conducted. The use of advanced air compressors, having variable speed and guide vane position control, results in additional power savings. The study also led to the conceptual design of a new air separation process, sized for a 500 MW sub e MHD plant, referred to a internal compression is discussed. In addition to its lower overall energy consumption, potential capital cost savings were identified for air separation plants using this process when constructed in a single large air separation train rather than multiple parallel trains, typical of conventional practice. B.W.

**N82-26807\*#** National Aeronautics and Space Administration.  
Lewis Research Center, Cleveland, Ohio.

**MOD-2 WIND TURBINE SYSTEM CLUSTER RESEARCH TEST PROGRAM. VOLUME 1: INITIAL PLAN E-1290 Final Report**

L. H. GORDON Mar. 1982 92 p refs 2 Vol.  
(NASA-TM-82906; NAS 1.15:82906; DOE/NASA/20305-8) Avail: NTIS HC A05/MF A01 CSCL 10A

Upon completion of the design and development of three Mod-2 wind turbines, a series of research experiments are planned to gather data on and evaluate the performance, environmental effects, and operation of a cluster as well as a single, large multimewatt wind turbine. Information on the program objectives, a Mod-2 system description, a planned schedule, organizational roles, and responsibilities, is included. T.M.

**N82-26823#** Sandia Labs., Albuquerque, N. Mex.  
**DYNAMIC ANALYSIS OF DARRIEUS VERTICAL AXIS WIND TURBINE ROTORS**

D. W. LOBITZ May 1981 26 p refs  
(Contract DE-AC04-76DP-00789)  
(DE82-000814; SAND-80-2820) Avail: NTIS HC A03/MF A01

The dynamic response characteristics of the VAWT rotor are important factors governing the safety and fatigue life of VAWT systems. The principal problems are the determination of critical rotor speeds (resonances) and the assessment of forced vibration response amplitudes. The solution to these problems is complicated by centrifugal and Coriolis effects which can have substantial influence on rotor resonant frequencies and mode shapes. The primary tools now in use for rotor analysis are described. These tools include a lumped spring mass model (VAWTDYN) and also finite element based approaches. The discussion centers on the accuracy and completeness of current capabilities and plans for future research. T.M.

**N82-26828#** Sandia Labs., Albuquerque, N. Mex.  
**USER'S MANUAL FOR THE VERTICAL AXIS WING TURBINE CODE VDART2**

J. H. STRICKLAND, T. SMITH, and K. SUN Sep. 1981 70 p refs  
(Contract DE-AC04-76DP-00789)  
(DE82-000796; SAND-81-7039) Avail: NTIS HC A04/MF A01

This user's manual provides details on the Darrieus wind turbine aerodynamic performance/loads prediction computer code, VDART2. The code is the latest generation of vortex-based models

and includes the effects of dynamic stall, pitching circulation, and added mass. DOE

**N82-26832#** JBF Scientific Corp., Wilmington, Mass.  
**METHODOLOGY FOR DETERMINING THE VALUE OF WIND ENERGY CONVERSION SYSTEMS FOR SPECIFIC UTILITY SYSTEMS**

Sep. 1981 35 p refs Prepared for Midwest Research Inst., Golden, Colo.  
 (Contract DE-AC02-77CH-00178; EG-77-C-01-4042)  
 (DE82-002679; SERI/TR-98336-2) Avail: NTIS HC A03/MF A01

The methodology uses to the maximum extent possible techniques that the electric utility industry developed to determine the relative economic attractiveness of alternative generation expansion plans. Three factors are emphasized in the methodology: the site dependence of wind resources, the inability to control the electrical output of wind energy conversion systems, and the lack of reliable WECS cost information. T.M.

**N82-26841#** Rockwell International Corp., Golden, Colo. Energy Systems Group.  
**SMALL WIND SYSTEMS APPLICATION ANALYSIS. EXECUTIVE SUMMARY**

Jun. 1981 32 p Prepared in cooperation with JBF Scientific Corp., Washington  
 (Contract DE-AC04-76DP-03533)  
 (DE82-004206; RFP-3147/1) Avail: NTIS HC A03/MF A01

The potential market for SWECS, or wind machines smaller than 100 kW for five selected applications was estimated. The goals of the study were to aid manufacturers in attaining financing by convincing venture capital investors of the potential of SWECS and to aid government planners in allocating R and D expenditures that will effectively advance SWECS commercialization. The five applications were selected through an initial screening and priority-ranking analysis. The year of analysis was 1985, but all dollar amounts, such as fuel costs, are expressed in 1980 dollars. The five SWECS applications investigated were farm residences, non-farm residences rural electric cooperatives, feed grinders, and remote communities. T.M.

**N82-26844#** Argonne National Lab., Ill. Engineering Applications Section.

**COMPARISON OF RANKINE-CYCLE POWER SYSTEMS: EFFECTS OF SEVEN WORKING FLUIDS**

T. J. MARCINIAK, J. L. KRAZINSKI (Purdue Univ., Hammond, Ind.), J. C. BRATIS, H. M. BUSHBY, and E. H. BUYCO Jun. 1981 88 p refs

(Contract W-31-109-ENG-38)  
 (DE82-005599; ANL/CNSV-TM-87) Avail: NTIS HC A05/MF A01

The safety, technical, and economic issues surrounding the prime working-fluid candidates for industrial Rankine-cycle power systems in the range of 600 to 2400 kW are investigated. These fluids are water, methanol, 2-methyl pyridine/H<sub>2</sub>O, Fluorinol 85, toluene, Freon R 11, and Freon R 113. At temperatures below about 7000F (3710C), steam systems become less efficient and too expensive to be used. However, other working fluids, usually organic compounds, can be economically attractive at the lower temperatures. This study shows that, at current and projected energy costs, Rankine-cycle power systems using any of the seven working fluids investigated here can exceed the minimum return on investment (ROI) criteria of most industries. The highest ROIs occur for those systems using a 3000F (1490C) condensing stream as the heat source. There appear to be no significant health or safety problems that would prevent the use of any of the candidate working fluids. The only limitation of an organic fluid is its maximum stability temperature, which may prevent its use with high-temperature waste-heat streams. DOE

**N82-26853#** Tennessee Univ. Space Inst., Tullahoma. Space Inst.

**MHD COAL-FIRED FLOW FACILITY Annual Technical Progress Report, Oct. 1979 - Sep. 1980**

M. C. ALSTATT, R. C. ATTIG, D. A. BROSNAN, J. N. CHAPMAN, R. W. CLEMONS, T. A. CLICK, J. A. COOPER, L. W. CRAWFORD, J. B. DICKS, and T. E. DWODY Mar. 1981 27 p refs  
 (Contract DE-AC01-76ET-10757; DE-AC02-79ET-10815)  
 (DE82-003814; DOE/ET-10815/59) Avail: NTIS HC A03/MF A01

Significant activity, task status, planned research, testing, development, and conclusions for the magnetohydrodynamics (MHD) coal fired flow facility (CFFF) and the energy conversion facility (ECF) is reported. The following tasks are considered: (1) compilation of design and construction of the CFFF and activation; (2) design and fabrication of the 8PPS test equipment; (3) phase operations for the CFFF and EC facility; (4) 8PPS high slag throughput testing; (5) testing of DOE supplied components; (6) modifications of the CFFF; and (7) technology development program. DOE

**N82-27081#** Artec Associates, Inc., Hayward, Calif.

**MHD PHENOMENA AT HIGH MAGNETIC REYNOLDS NUMBER Final Report**

S. P. GILL and D. MUKHERJEE Dec. 1981 104 p refs  
 (Contract N00014-79-C-0565; NR PROJ. 099-429)  
 (AD-A110929; FR-137) Avail: NTIS HC A06/MF A01 CSCL 20C

Exact MHD solutions have been derived for the propagation of a shock-ionized plasma through applied magnetic field configurations pertinent to two- and three-dimensional MHD generators and plasma diagnostics. Calculated magnetic field perturbations and Faraday voltages are presented for a wide range of magnetic Reynolds number. The solutions provide insight into eddy current and magnetic diffusion effects in MHD generator sections. Author (GRA)

**N82-27141#** Naval Weapons Center, China Lake, Calif. Physics Div.

**EXPLOSION DRIVEN MAGNETOGASDYNAMIC FLOWS WITH HIGH MAGNETIC REYNOLDS AND INTERACTION NUMBERS Annual Report, 1 Feb. - 30 Sep. 1981**

H. E. WILHELM 1 Dec. 1981 120 p refs  
 (Contract N00014-81-WR-10107)  
 (AD-A112049) Avail: NTIS HC A06/MF A01 CSCL 20C

Detonation driven magnetogasdynamic generators with external R-L load circuits are analyzed, for which the external and induced magnetic fields are parallel and antiparallel, respectively. Two plasma shock flow models are treated: (1) implosion produced jet flow and (2) plane detonation flow. A theory of power generation is developed for a stress polarizable solid between plane electrodes (with an external ohmic load circuit), which is electrically polarized by an explosion produced stress shock wave. In connection with the analysis of flux compression power generators, initial-boundary-value problems for the diffusion of magnetic fields into conductors with external electromagnetic transients and the electromagnetic induction in conductors accelerated in external magnetic fields are solved. A quantum-kinetic theory of the anomalous electron heating in plasmas by high-frequency electromagnetic fields is presented. Author (GRA)

**N82-27142#** ARO, Inc., Arnold Air Force Station, Tenn.

**HIGH POWER MHD SYSTEM: FACILITY STATUS AND MAGNET TEST RESULTS Final Report, 1 Jul. 1977 - 30 Sep. 1980**

G. L. WHITEHEAD AEDC Feb. 1982 107 p refs  
 (AD-A112102; AEDC-TR-81-14) Avail: NTIS HC A06/MF A01 CSCL 20C

AEDC has been requested by the Aero Propulsion Laboratory to design, fabricate, and install facility hardware necessary to conduct tests to demonstrate the performance of high power MHD generator systems developed by AFWAL contractors. This report summarizes the AEDC effort since program inception, describes the facility under development, gives the status of each major

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facility component, and summarizes the results of the data acquired during magnet checkout tests. The report also describes the future effort required to make the facility a useful tool for MHD generator system and component development. Author (GRA)

**N82-27151#** California Univ., Livermore. Lawrence Livermore Lab.

### **DESIGN SCOPING STUDY OF THE 12T YIN-YANG MAGNET SYSTEM FOR THE TANDEM MIRROR NEXT STEP (TMNS) Final Report**

Sep. 1981 308 p refs Prepared in cooperation with General Dynamics/Convair, San Diego (Contract W-7405-ENG-48)

(DE82-003218; UCRL-15405) Avail: NTIS HC A14/MF A01

The feasibility of designing a Yin-Yang magnet capable of producing a peak field in the windings of 12T for the Tandem Mirror Next Step (TMNS) program was determined. A rough order of magnitude (ROM) cost estimate of the winding for this magnet was undertaken. The preferred approach to the winding design of the TMNS plug coil utilizes design concepts to meet the structural, electrical and thermodynamic requirements of the magnet system. Structurally, the coil is radially partitioned into four sections, preventing the accumulation of the radial loads and reacting them into the structural case. To safely dissipate the 13.34 GJ of energy stored in each Yin-Yang magnet, the winding is electrically subdivided into parallel or nested coils, each with its own power supply and protection circuitry. The arrangement divides the total stored energy of the coils into manageable subsystems. The windings are cooled with superfluid helium 2, operated at 1.8K and 1.2 atmospheres. DOE

**N82-27155#** Westinghouse Electric Corp., Pittsburgh, Pa. Advanced Energy Systems Div.

### **MHD GENERATOR ELECTRODE DEVELOPMENT Quarterly Report, Apr. - Jun. 1981**

F. D. RETALLICK, D. L. DIETRICK, I. LLOYD, B. R. ROSSING, and R. SMITH Aug. 1981 65 p refs (Contract DE-AC01-79ET-15529)

(DE82-002561; DOE/ET-15529/11) Avail: NTIS HC A04/MF A01

Metallurgical and engineering understanding of cold metallic electrode alternatives to the continued use of platinum as an anode clad material is discussed. The results of evaluating materials for MHD electrodes through use of a laboratory electrochemical and arc test are presented. Results for standard available materials as well as for some specially fabricated ones are presented. The development of a high temperature (11000 C to 14000 C) electrochemical test is outlined. Initial operation of the Westinghouse Electrode Systems Test Facility (WESTF), since major modification to include a magnet, is reported for a test section designed to operate as a small scale MHD generator and for test sections designed for the purpose of materials test evaluation in the operating MHD plasma environment. DOE

**N82-27172#** Riso National Lab., Roskilde (Denmark). Metallurgy Dept.

### **INTRODUCTION TO PROTON CONDUCTION IN SOLIDS**

F. W. POULSEN Sep. 1980 23 p refs

(RISO-M-2244) Avail: NTIS (US Sales Only) HC A02/MF A01; DOE Depository Libraries Also available from Issuing Activity

Fuel cell and other possible applications of solid proton conductors are described. The best performing materials known today are listed. Typical synthetic routes and some models for proton transport in solids are discussed. Hints to future research are given. The literature collected for this report covers mainly the period 1974-1980. DOE

**N82-27193#** R and D Associates, Marina Del Rey, Calif.

### **CONCEPT EVALUATION OF AUTOMOTIVE PROPULSION USING LIQUID AIR/NITROGEN. TASK 1 REPORT. THERMODYNAMICS.**

J. L. DOOLEY and R. P. HAMMOND Oct. 1981 56 p refs

(Contract DE-AC01-81ER-30011)

(DE82-002460; RDA-TR-118700-001) Avail: NTIS HC A04/MF A01

An automotive powerplant system using cryogenic liquid air or nitrogen as the working fluid in a powerplant operating on an open Rankine type cycle was assessed. The cold fluid is pressurized, heat energy is added to form hot gas and is expanded to atmospheric conditions in the engine which drive the vehicle. A range of gas pressures and temperatures as well as different expansion stages and reheat configurations are evaluated. The thermodynamic results indicate that this powerplant concept can be competitive with a comparable gasoline engine to give a vehicle equal in performance, weight, range and operating cost without using imported fuel. DOE

**N82-27837\*#** Gilbert/Commonwealth, Reading, Pa.

### **MAGNETOHYDRODYNAMICS (MHD) ENGINEERING TEST FACILITY (ETF) 200 MWE POWER PLANT. CONCEPTUAL DESIGN ENGINEERING REPORT (CDER). VOLUME 2: ENGINEERING. VOLUME 3: COSTS AND SCHEDULES Final Report**

Sep. 1981 163 p Volume 3 is included as MF 5 Vol.

(Contract DEN3-224; DE-AI01-77ET-10769)

(NASA-CR-165452-VOL-2; NASA-CR-165452-VOL-3; NAS

1.26:165452-VOL-2; NAS 1.26:165452-VOL-3;

DOE/NASA/0224-1) Avail: NTIS HC E08/MF A01 CSCL 10B

Engineering design details for the principal systems, system operating modes, site facilities, and structures of an engineering test facility (ETF) of a 200 MWE power plant are presented. The ETF resembles a coal-fired steam power plant in many ways. It is analogous to a conventional plant which has had the coal combustor replaced with the MHD power train. Most of the ETF components are conventional. They can, however, be sized or configured differently or perform additional functions from those in a conventional coal power plant. The boiler not only generates steam, but also performs the functions of heating the MHD oxidant, recovering seed, and controlling emissions. S.L.

**N82-27838\*#** National Aeronautics and Space Administration. Lewis Research Center, Cleveland, Ohio.

### **COMPARATIVE ANALYSIS OF THE CONCEPTUAL DESIGN STUDIES OF POTENTIAL EARLY COMMERCIAL MHD POWER PLANTS (CSPEC)**

R. J. SOVIE, J. M. WINTER, A. J. JUHASZ, and R. D. BERG (Gilbert Associates, Inc.) 1982 27 p refs Presented at the 20th Symp. on the Eng. Aspects of Magnetohydrodyn., Irvine, Calif., 14-16 Jun. 1982

(Contract DE-AI01-77ET-10769)

(NASA-TM-82897; DOE/NASA/10769-26; NAS 1.15:82897)

Avail: NTIS HC A03/MF A01 CSCL 10B

A conceptual design study of the MHD/steam plant that incorporates the use of oxygen enriched air preheated in a metallic heat exchanger as the combustor oxidant showed that this plant is the most attractive for early commercial applications. The variation of performance and cost was investigated as a function of plant size. The contractors' results for the overall efficiencies are in reasonable agreement considering the slight differences in their plant designs. NASA LeRC is reviewing cost and performance results for consistency with those of previous studies, including studies of conventional steam plants. LeRC in house efforts show that there are still many tradeoffs to be considered for these oxygen enriched plants and considerable variations can be made in channel length and level of oxygen enrichment with little change in overall plant efficiency. A.R.H.

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**N82-27846#** Thermo Electron Corp., Waltham, Mass.  
**ADVANCED THERMIONIC TECHNOLOGY PROGRAM Progress Report, Apr. - Jun. 1981**

1981 32 p refs  
(Contract DE-AC02-76ET-11292)  
(DE82-002116; TE-4258-25-82; PR-47; COO-3056-47) Avail: NTIS HC A03/MF A01

Improvement of thermionic performance to the level that thermionic topping of fossil fuel powerplants becomes technically possible and economically attractive was investigated. The operation of a thermionic module in a power plant during the mid 1980's and to demonstrate reliable thermionic operation in a combustion environment were studied. Reported accomplishments include: (1) continuing stable output from the combustion test of the one inch diameter hemispherical silicon carbide diode (Converter No. 239) at an emitter temperature of 1730 K for a period of over 8500 hours; (2) determination of the elemental composition (i.e., molybdenum, nickel and cesium) through the sublimed molybdenum collector of Converter No. 262; and (3) demonstration of tungsten CVD onto molybdenum flange using a reuseable graphite mandrel. DOE

**N82-27848#** Case Western Reserve Univ., Cleveland, Ohio.  
**OXYGEN ELECTRODES FOR ENERGY CONVERSION AND STORAGE Annual Report, 1 Oct. 1979 - 30 Sep. 1980**

5 Nov. 1981 284 p refs  
(Contract DE-AC02-77ET-25502)  
(DE82-005305; DOE/ET-25502/3) Avail: NTIS HC A13/MF A01

The main theme of this project has been to develop high performance oxygen electrodes for a spectrum of applications including industrial electrolysis, metal-air batteries and fuel cells. The research at CWRU emphasizes the development of more effective electrocatalysts for both O<sub>2</sub> reduction and electrogeneration and also more effective electrode structures (particularly for O<sub>2</sub> cathodes) for utilizing these catalysts. The approach used by the CWRU group involves the development of a predictive base to guide the search for the new catalysts systems. The DSC group is concerned principally with the evaluations of catalysts developed and recommended by CWRU as well as by their own staff and the fabrication of electrode structures for these evaluations. Progress is reported in detail. DOE

**N82-27850#** Kusko (Alexander), Inc., Needham Heights, Mass.  
**POWER SUPPLY SUBSYSTEM FOR MHD GENERATOR SUPERCONDUCTING MAGNET, BASELINE POWER SUPPLY DESIGNS AND COSTS**

A. KUSKO and S. M. PEERAN 10 Apr. 1981 154 p refs  
(Contract DE-AT01-76ET-10813)  
(DE81-024285; DOE/ET-10813/T1) Avail: NTIS HC A08/MF A01

An analysis of the dc power supply requirements for superconducting magnets used in MHD generators of ratings 250 MW sub e to 1000 MW sub e is presented. The power supplies considered are rated for a peak power of 10 MW and for currents of 20 kA to 100 kA. The various aspects discussed include: rectifier configurations and specifications, control requirements, dumping the magnet energy, and rectifier size, arrangement and cost. (WHK) DOE

**N82-27853#** VSE Corp., Alexandria, Va.  
**OTEC SUPPORT SERVICES Quarterly Technical Progress Report, 15 Aug. - 14 Nov. 1981**

Nov. 1981 15 p  
(Contract DE-AC02-78ET-21002)  
(DE82-005470; DOE/ET-21002/T20; QTPR-14) Avail: NTIS HC A02/MF A01

Progress in system integration, system engineering, and management services is reported. The effort is divided into seven tasks: survey, analysis, and evaluation of technical program status; program technical monitoring; development and implementation of methodology for identification, evaluation, and tradeoff for major subsystem configurations; technical assessments; OTEC system

integration; environment and siting considerations; and transmission subsystem considerations. DOE

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### ENERGY TRANSPORT, TRANSMISSION, AND DISTRIBUTION

Includes transport of fuels by pipelines, tubes, etc., microwave power transmission, and superconducting power transmission.

**A82-31897#**  
**OSMOTIC PUMPED HEAT PIPES FOR LARGE SPACE PLATFORMS**

H. J. TANZER, G. L. FLEISCHMAN (Hughes Aircraft Co., Torrance, CA), and D. D. STALMACH (Vought Corp., Dallas, TX) American Institute of Aeronautics and Astronautics and American Society of Mechanical Engineers, Joint Thermophysics, Fluids, Plasma and Heat Transfer Conference, 3rd, St. Louis, MO, June 7-11, 1982, AIAA 11 p. refs  
(AIAA PAPER 82-0902)

A thermal bus will be required as a thermal control source for future space platforms. The osmotic heat pipe is one candidate device with potential significant payoff toward serving growing thermal management needs. Results of a study evaluating osmotic heat pipes for thermal bus applications are presented. Electrostatic and other techniques are proposed for flow control and solution circulation in zero-gravity. Baseline size and performance design parameters of cellulose acetate membrane/sugar-water solution and other combinations were scaled up to predict osmotic pump performance for heat loads and temperatures of 4 to 120 C. A compact hollow-fiber membrane module measuring 20 inches in diameter by 12 inches long and weighing 190 pounds is projected for 50-kW heat loads. (Author)

**A82-31898\*#** Hughes Aircraft Co., Torrance, Calif.  
**DESIGN, FABRICATION AND TEST OF LIQUID METAL HEAT-PIPE SANDWICH PANELS**

A. BASIULIS (Hughes Aircraft Co., Torrance, CA) and C. J. CAMARDA (NASA, Langley Research Center, Hampton, VA) American Institute of Aeronautics and Astronautics and American Society of Mechanical Engineers, Joint Thermophysics, Fluids, Plasma and Heat Transfer Conference, 3rd, St. Louis, MO, June 7-11, 1982, AIAA 8 p. refs  
(AIAA PAPER 82-0903)

Integral heat-pipe sandwich panels, which synergistically combine the thermal efficiency of heat pipes and the structural efficiency of honeycomb sandwich panel construction, were fabricated and tested. The designs utilize two different wickable honeycomb cores, facesheets with screen mesh sintered to the internal surfaces, and potassium or sodium as the working fluid. Panels were tested by radiant heating, and the results indicate successful heat pipe operation at temperatures of approximately 922 K (1200 F). These panels, in addition to solving potential thermal stress problems in an Airframe-Integrated Scramjet Engine, have potential applications as cold plates for electronic component cooling, as radiators for space platforms, and as low distortion, large area structures. (Author)

**A82-32368\***  
**METEOROLOGICAL EFFECTS ON LASER PROPAGATION FOR POWER TRANSMISSION**

R. E. BEVERLY, III Space Solar Power Review, vol. 3, no. 1, 1982, p. 9-29. refs  
(Contract NAS8-32475)

An examination of possible laser operating parameters for power transmission to earth from solar power satellites is presented, with particular attention paid to assuring optimal delivery at midlatitudes. The degradation of beam efficiency due to molecular scattering, molecular absorption, aerosol scattering, and aerosol

## 06 ENERGY TRANSPORT, TRANSMISSION, AND DISTRIBUTION

absorption during beam propagation through the atmosphere can be alleviated by judicious choice of wavelength windows, elevating the receptor sites, using a vertical propagation path, or by hole boring, i.e., vaporizing the aerosol particles in the beam path. Analyses are given for the beam propagation through fog, haze, clouds, and snow using various transitions. Only weapons-quality lasers are seen as being capable of boring through clouds and aerosols, employing a CW beam with superimposed pulses at high power densities. It is concluded that further short wavelength transmission experiments be performed to demonstrate transmission feasibility with the CW/pulsed mode of beam propagation. M.S.K.

### A82-32369\*

#### POWER AVAILABILITY AT TERRESTRIAL RECEPTOR SITES FOR LASER-POWER TRANSMISSION FROM THE SATELLITE POWER SYSTEM

R. E. BEVERLY, III Space Solar Power Review, vol. 3, no. 1, 1982, p. 31-44. refs  
(Contract NAS8-32475)

A statistical model was developed for relating the temporal transmission parameters of a laser beam from a solar power satellite to observable meteorological data to determine the influence of weather on power reception at the earth-based receiver. Sites within 100 miles of existing high voltage transmission lines were examined and the model was developed for clear-sky and clouded conditions. The cases of total transmission through clouds at certain wavelengths, no transmission, and partial transmission were calculated for the cloud portion of the model. The study covered cirriform, stratiform, cumiliform, and mixed type clouds and the possibility of boring holes through the clouds with the beam. Utilization of weapons-quality beams for hole boring, was found to yield power availability increases of 9-33%, although no beneficial effects could be predicted in regions of persistent cloud cover. An efficiency of 80% was determined as possible if several receptor sites were available within 200-300 miles of each other, thereby allowing changes of reception point in cases of unacceptable meteorological conditions. M.S.K.

### A82-32370

#### LASER SATELLITE POWER SYSTEMS - CONCEPTS AND ISSUES

E. W. WALBRIDGE (Argonne National Laboratory, Argonne, IL) Space Solar Power Review, vol. 3, no. 1, 1982, p. 45-71. Research supported by the U.S. Department of Energy. refs

A laser satellite power system (SPS) converts solar power captured by Earth-orbiting satellites into electrical power on the Earth's surface, the satellite-to-ground transmission of power being effected by a laser beam. The laser SPS is an alternative to the microwave SPS. Lasers and how they work are described, as are the types of lasers - electric discharge, direct and indirect solar pumped, free electron, and closed-cycle chemical - that are candidates for application in a laser SPS. The advantages of a laser SPS over the microwave alternative are pointed out. One such advantage is that, for the same power delivered to the utility busbar, land requirements for a laser system are much smaller (by a factor of 21) than those for a microwave system. The four laser SPS concepts that have been presented in the literature are described and commented on. Finally key issues for further laser SPS research are discussed. (Author)

### A82-33447

#### SIMULATION OF D AND E REGION HIGH-POWER MICROWAVE HEATING WITH HF IONOSPHERIC MODIFICATION EXPERIMENTS

G. MELTZ (United Technologies Research Center, East Hartford, CT), C. M. RUSH, and E. J. VIOLETTE (National Telecommunications and Information Administration, Institute for Telecommunication Sciences, Boulder, CO) Radio Science, vol. 17, May-June 1982, p. 701-715. refs

The satellite power system is to utilize a microwave beam for the transmission of electric power to earth. It is, therefore, important to investigate the possible effects of such beams on the operation

of telecommunication systems. In 1979 and 1980 a series of heating experiments were conducted using the high-power HF transmitter facility at Platteville, Colorado, to investigate the effects of ionospheric heating on the performance of certain telecommunications systems. The present investigation has the objective to compare the results of ionospheric changes obtained during these experiments with the theoretical estimates of the expected electron temperature and density changes. The described results were obtained by heating the ionosphere with 5.2- and 9.9-MHz high-powered signals and using a pulse ionosonde probe to detect the changes in the D and lower E regions. G.R.

N82-22444# Westinghouse Research and Development Center, Pittsburgh, Pa.

#### MATERIALS RESEARCH FOR HYDROGEN-COOLED SUPERCONDUCTING POWER TRANSMISSION LINES Quarterly Report, 1 Jan. - 31 Mar. 1981

A. M. SLETTEN, A. I. BRAGINSKI, M. ROSADO, and J. R. GAVALER 1981 18 p refs  
(Contract DE-AC04-79ET-29354)  
(DE82-002170; DOE/ET-29354/T2; QR-5) Avail: NTIS HC A02/MF A01

Dielectric breakdown and loss measurements in liquid hydrogen and liquid hydrogen impregnated synthetic dielectrics, at temperatures between 14 and 200K and at hydrostatic pressures up to 5 atmospheres are performed. Effects of dissolved impurities/additives in the liquid are included. The self field and low field superconducting properties of high critical temperature materials are characterized at temperatures between approximately 14 and 200K. The experiments on dielectrics were conducted outdoors, due to safety considerations. The Design of the auxiliary equipment for the tests on the dielectric properties of LH2 was finished, and all the key components were ordered. A safety analysis report was started to discuss the effect of the setting on the safety aspects of this project; the design of the system of small electrodes was modified to provide individual ground connections for each ground electrode; data on Tc vs. composition was obtained for several samples of carbon doped V3Si; and the Nb3 Ge chemical vapor deposition apparatus was reactivated. DOE

N82-22722\*# Mathematical Sciences Northwest, Inc., Bellevue, Wash.

#### SOLAR DRIVEN LASERS FOR POWER SATELLITE APPLICATIONS

R. TAUSSIO, P. CASSADY, and E. KLOSTERMAN In NASA, Washington The Final Proc. of the Solar Power Satellite Program Rev. p 267-270 Jul. 1980  
Avail: NTIS HC A99/MF A01 CSCL 10A

The technological feasibility of using multimagawatt lasers for space power transmission is discussed. Candidate lasers include electric discharge lasers, direct optically pumped lasers, and free electron lasers. J.D.

N82-22723\*# National Aeronautics and Space Administration, Lyndon B. Johnson Space Center, Houston, Tex.

#### POWER TRANSMISSION AND RECEPTION. AN OVERVIEW AND PERSPECTIVE

R. H. DIETZ In NASA, Washington The Final Proc. of the Solar Power Satellite Program Rev. p 273-276 Jul. 1980  
Avail: NTIS HC A99/MF A01 CSCL 10A

Systems definition and assessment of the microwave power transmission and reception (PTAR) system for the solar power satellite are surveyed. Five different options are discussed and the separate antenna concept using the linear beam klystron to convert from dc to RF energy is described in detail. J.D.

**N82-22724\*#** National Aeronautics and Space Administration. Lyndon B. Johnson Space Center, Houston, Tex.

## MICROWAVE SYSTEM PERFORMANCE SUMMARY

G. D. ARNDT and E. J. NALOS (Boeing Co., Seattle) /in NASA, Washington The Final Proc. of the Solar Power Satellite Program Rev. p 277-280 Jul. 1980

Avail: NTIS HC A99/MF A01 CSCL 10A

The design of the microwave system for the solar power satellite is described. Design modifications recommended include changes in phase control to the power module level, a reduction in allowable amplitude jitter, the use of metal matrix waveguides, and sequences for startup/shutdown procedures. Investigations into reshaping the beam pattern to improve overall rectenna collection efficiency and improve sidelobe control are surveyed.

**N82-22736\*#** Jet Propulsion Lab., California Inst. of Tech., Pasadena.

## RECTENNA SYSTEM DESIGN

W. C. BROWN (Raytheon Co., Waltham, Mass.), R. M. DICKINSON, E. J. NALOS (Boeing Aerospace Co.), and J. H. OTT (Nova Electronics Corp.) /in NASA, Washington The Final Proc. of the Solar Power Satellite Program Rev. p 328-331 Jul. 1980

Avail: NTIS HC A99/MF A01 CSCL 10A

The function of the rectenna in the solar power satellite system is described and the basic design choices based on the desired microwave field concentration and ground clearance requirements are given. One important area of concern, from the EMI point of view, harmonic reradiation and scattering from the rectenna is also designed. An optimization of a rectenna system design to minimize costs was performed. The rectenna cost breakdown for a 56 w installation is given as an example. M.D.K.

**N82-22739\*#** Rockwell International Corp., Anaheim, Calif.

## SOLID-STATE CONFIGURATIONS

K. G. SCHROEDER /in NASA, Washington The Final Proc. of the Solar Power Satellite Program Rev. p 340-343 Jul. 1980

Avail: NTIS HC A99/MF A01 CSCL 10A

Two prototype solid-state phased array systems concepts developed for the solar power satellite (SPS) are described. In both concepts, the beam was centered on the rectenna by means of phase conjugation of a pilot signal emanating from the ground. Also discussed are results of solid state studies. M.D.K.

**N82-22741\*#** Rice Univ., Houston, Tex.

## OFFSHORE RECTENNA FEASIBILITY

J. W. FREEMAN, D. HERVEY (Brown and Root Development, Inc.), and P. GLASER (Arthur D. Little, Inc.) /in NASA, Washington The Final Proc. of the Solar Power Satellite Program Rev. p 348-351 Jul. 1980

Avail: NTIS HC A99/MF A01 CSCL 10A

A preliminary study of the feasibility and cost of an offshore rectenna to serve the upper metropolitan east coast was performed. A candidate site at which to build a 5 GW rectenna was selected on the basis of proximity to load centers, avoidance of shipping lanes, sea floor terrain, and relocated conditions. Several types of support structures were selected for study based initially on the reference system rectenna concept of a wire mesh ground screen and dipoles each with its own rectifier and filter circuits. Possible secondary uses of an offshore rectenna were examined and are evaluated. M.D.K.

**N82-22742\*#** Massachusetts Inst. of Tech., Cambridge. Space Systems Lab.

## HIGH-POWER MICROWAVE OPTICS FOR FLEXIBLE POWER TRANSMISSION SYSTEMS

K. E. DREXLER and B. R. SPERBER (Boeing Aerospace Co.) /in NASA, Washington The Final Proc. of the Solar Power Satellite Program Rev. p 352-355 Jul. 1980 refs

Avail: NTIS HC A99/MF A01 CSCL 10A

A large concave microwave mirror near the transmitter can magnify the apparent size of the Earth as seen from a phased array, and vice versa, permitting a small phased array to be coupled to a small rectenna while preserving the transmission efficiency

(the reflection loss is slight) and peak power densities characteristic of the reference system. This augmentation of the phased array aperture with a large mirror gives the system greater resolution (in the optical sense), and opens new degrees of freedom in SPS design. The consequences of such an approach for a prototype satellite were explored. Its consequences for a mature SPS are discussed. N.W.

**N82-22743\*#** National Aeronautics and Space Administration. Marshall Space Flight Center, Huntsville, Ala.

## ELECTRIC POWER PROCESSING, DISTRIBUTION, MANAGEMENT AND ENERGY STORAGE

R. J. GIUDICI /in NASA, Washington The Final Proc. of the Solar Power Satellite Program Rev. p 359-363 Jul. 1980

Avail: NTIS HC A99/MF A01 CSCL 10A

Power distribution subsystems are required for three elements of the SPS program: (1) orbiting satellite, (2) ground rectenna, and (3) Electric Orbiting Transfer Vehicle (EOTV). Power distribution subsystems receive electrical power from the energy conversion subsystem and provide the power busses rotary power transfer devices, switchgear, power processing, energy storage, and power management required to deliver control, high voltage plasma interactions, electric thruster interactions, and spacecraft charging of the SPS and the EOTV are also included as part of the power distribution subsystem design. N.W.

**N82-22744\*#** Rockwell International Corp., Downey, Calif.

## HIGH VOLTAGE SYSTEMS (TUBE-TYPE MICROWAVE)/LOW VOLTAGE SYSTEM (SOLID-STATE MICROWAVE) POWER DISTRIBUTION

A. A. NUSSBERGER and G. R. WOODCOCK (Boeing Aerospace Co., Seattle) /in NASA, Washington The Final Proc. of the Solar Power Satellite Program Rev. p 364-367 Jul. 1980

Avail: NTIS HC A99/MF A01 CSCL 10A

SPS satellite power distribution systems are described. The reference Satellite Power System (SPS) concept utilizes high-voltage klystrons to convert the onboard satellite power from dc to RF for transmission to the ground receiving station. The solar array generates this required high voltage and the power is delivered to the klystrons through a power distribution subsystem. An array switching of solar cell submodules is used to maintain bus voltage regulation. Individual klystron dc voltage conversion is performed by centralized converters. The on-board data processing system performs the necessary switching of submodules to maintain voltage regulation. Electrical power output from the solar panels is fed via switch gears into feeder buses and then into main distribution buses to the antenna. Power also is distributed to batteries so that critical functions can be provided through solar eclipses. N.W.

**N82-22747\*#** United Technologies Corp., East Hartford, Conn.

## MICROWAVE HEATING OF THE LOWER IONOSPHERE

G. MELTZ and W. L. NIGHAN /in NASA, Washington The Final Proc. of the Solar Power Satellite Program Rev. p 403-406 Jul. 1980 refs

Avail: NTIS HC A99/MF A01 CSCL 10A

Changes in the properties of the lower ionosphere due to ohmic heating of the plasma by the solar power satellite (SPS) microwave power beam are considered. The development of a predictive model of the underdense interaction of an electromagnetic beam and the lower ionosphere is described. The extent to which the Platteville and Arecibo experiments simulate SPS conditions is considered. J.D.

## 06 ENERGY TRANSPORT, TRANSMISSION, AND DISTRIBUTION

**N82-23412#** National Bureau of Standards, Washington, D.C. Thermophysical Properties Div.  
**HELIUM RESEARCH IN SUPPORT OF SUPERCONDUCTING POWER TRANSMISSION** Annual Report, 1 Oct. 1979 - 1 Sep. 1980

D. E. DANNEY, ed. Sep. 1981 45 p refs -Sponsored in part by Brookhaven National Lab.

(PB82-122987; NBSIR-81-1649) Avail: NTIS HC A03/MF A01 CSCL 09C

In developing superconducting power transmission line cooldown strategies a computer code was used to explore cooldown times for a wide variety of realistic boundary conditions. Cooldown times of 10 days are feasible with only minor modification to previously proposed refrigeration systems if cooling channel lengths are reduced to two thirds or one half those dictated by steady state considerations. Evaluation of thermal flux meters was concluded. Below ground field tests revealed large effects due to seasonal variation in the soil heat flux. These effects are largely cancelled by algebraic addition of the signals from a pair of horizontally opposed sensors. A brief above ground field evaluation indicated that diurnal variations in the heat flux completely mask heat fluxes typical of the anticipated enclosure heat flux. GRA

**N82-24261#** Joint Publications Research Service, Arlington, Va. **COOPERATIVE EFFORT URGED FOR DEVELOPMENT OF ORBITAL POWER STATIONS**

R. AKHMETOV *In its* USSR Rept.: Space, No. 15 (JPRS-80424) p 62-65 29 Mar. 1982 Transl. into ENGLISH from Sots. Industr. (USSR), 22 Oct. 1981 p 4  
Avail: NTIS HC A07/MF A01

The concept of solar power stations is discussed in relation to construction, energy transmission, and support services. International interest and the benefits of international cooperation are considered. S.L.

**N82-27362\*#** Aerospace Corp., El Segundo, Calif. 22a **ADVANCED SPACE SYSTEM CONCEPTS AND THEIR ORBITAL SUPPORT NEEDS (1980 - 2000)**

J. BUTTS *In* NASA. Lewis Research Center Large Space Systems/Propulsion Interactions p 25-37 Jun. 1982  
Avail: NTIS HC A12/MF A01

Possible uses of satellite technology up to the year 2000 are suggested and discussed. Included are electronic mail transmission, a personal communications capability, quick location of vehicles or shipments, monitoring of disputed territorial borders, upgraded scientific exploration of the universe, providing better maps of the Earth by remote sensing, space solar power stations and the safe transmission of the electrical energy to Earth, night lighting, and a small personal navigation capability. Support requirements are outlined. L.F.M.

**N82-27405\*#** Massachusetts Inst. of Tech., Cambridge. **METALS PROCESSING**

*In its* Mater. Process. Res. Base of the Mater. Process. Center p 268-284 28 Jun. 1982 refs  
Avail: NTIS HC A13/MF A01 CSCL 11F

The metals processing effort is directed towards improvement of performance and usefulness of materials through modification and control of shape and internal structure. Interaction of reactive gases, introduced into a plasma arc, with iron alloys were analyzed. The technology of magnesium production was assessed. The study of fast fluidized bed reactors is continued. Aspects of separation processes are being investigated. The development of high field superconducting composites for use in large magnetic fusion devices is also discussed. Processing, structure, and property relationships of superconducting materials and the substitution of precious metals in standard electrical contact and connector applications are tested. The influence of processing procedures on the structure of zircaloy and nickel base alloys with a goal of improving mechanical properties and performance is investigated. Investigation of the potential of metal insulator semiconductor junctions as photovoltaic devices is reported. E.A.K.

**N82-27664#** Naval Ship Research and Development Center, Bethesda, Md. Propulsion and Auxiliary Systems Dept.

**ACTIVE SUPERCONDUCTIVE GENERATOR DEVELOPMENT 400 HORSEPOWER GENERATOR DESIGN**

H. O. STEVENS and M. J. CANNELL Oct. 1981 119 p refs (AD-A107513; DTNSRDC/PAS-81-14) Avail: NTIS HC A06/MF A01 CSCL 10B

A superconductive acyclic generator has been designed and constructed using the unique current-carrying capabilities of superconducting wire in the field winding to produce a very high flux density in the rotor region. This, along with the use of liquid-metal current collectors in lieu of conventional brushes has yielded a very high power density machine designed to operate at gas turbine speeds. The nominal 300-kilowatt generator is 0.66 meter long and 0.46 meter in diameter (26 x 18 inches) and is designed to operate at 19,500 revolutions per minute. Extrapolation of the design analyses indicates no barriers to operation up to 750 kilowatts. Efficiencies of 98% are estimated over the practical operating range. GRA

**N82-27685#** National Mechanical Engineering Research Inst., Pretoria (South Africa). Fluid Mechanics Div.

**HYDRAULIC TRANSPORT OF COARSE SOLIDS IN CIRCULAR AND SEGMENTED PIPES**

H. B. SAUERMAN May 1981 165 p refs (CSIR-ME-1716; ISBN-0-7988-1479-9) Avail: NTIS HC A08/MF A01

A detailed investigation into the hydraulic transport of coarse solids in circular and segmented pipes is presented. The existing hydraulic transport pipelines carry relatively fine solids. It is believed that if coarse solids could be transported economically, many more hydraulic transport pipelines would come into operation. It is shown that by providing a wide bed, e.g., a base wear plate in a circular pipe (segmented pipe) to the sliding bed of coarse particles, the energy requirements for the same solids throughout in comparison with a circular pipe of the same diameter is, depending upon the position of the base wear plate and the solid material, reduced by up to 35%. Author

07

## ENERGY STORAGE

Includes flywheels, heat storage, underground air storage, compressed air, storage batteries, and electric hybrid vehicles.

**A82-28650**

**METAL HYDRIDES FOR ENERGY STORAGE**

D. G. IVEY and D. O. NORTHWOOD (Windsor, University, Windsor, Ontario, Canada) Canadian Metallurgical Quarterly, vol. 20, Oct.-Dec. 1981, p. 397-405. Research supported by the Natural Sciences and Engineering Research Council of Canada and Ontario Ministry of Energy. refs

Metal hydrides provide an efficient and safe method for storing hydrogen. Hydrogen can be stored indefinitely and released as needed for a number of energy usages. This paper conducts an overall review of the various alloys under consideration for hydrogen storage. The major classifications available are the AB compounds, AB<sub>5</sub> compounds, and the AB<sub>2</sub> or A<sub>2</sub>B compounds. Although none of these alloys fulfill storage criteria completely, a number of them show promise. (Author)

A82-31562

**ENERGY STORAGE CAPACITY OF ROTATING COMPOSITE DISKS AND SHELLS /REVIEW/ [ENERGOEMKOST' VRASHCHAIUSHCHIKHSIA DISKOV I OBOLOCHEK IZ KOMPOZITOV /OBZOR/]**

G. G. PORTNOV and I. U. M. TARNOPOLSKII (Akademiia Nauk Latviiskoi SSR, Institut Mekhaniki Polimerov, Riga, Latvian SSR) (Vsesoiuznyi S'ezd po Teoreticheskoi i Prikladnoi Mekhanike, 5th, Alma-Ata, Kazakh SSR, May-June 1981.) Mekhanika Kompozitnykh Materialov, Mar.-Apr. 1982, p. 290-300. In Russian. refs

Research in the field of composite flywheels is briefly reviewed. Particular attention is given to the energy storage capacity of filament-wound structures and optimum shapes and reinforcement patterns for rotating shells. The maximum mass energy storage capacity of flywheels made from state-of-the-art composite materials is estimated at 400-800 J/g as compared with 100-200 J/g for steel flywheels. Energy storage capacities are calculated for filament-wound epoxy-matrix composite disks reinforced with glass, carbon, boron, and organic fibers. V.L.

A82-31563

**ENERGY STORAGE CAPACITY OF ROTATING COMPOSITE STRUCTURES OPERATING UNDER UNIAXIAL TENSION [ENERGOEMKOST' VRASHCHAIUSHCHIKHSIA KONSTRUKTSII IZ KOMPOZITOV, RABOTAUSHCHIKH NA ODNOOSNOE RASTIAZHENIE]**

G. G. PORTNOV and V. A. POLIAKOV (Akademiia Nauk Latviiskoi SSR, Institut Mekhaniki Polimerov, Riga, Latvian SSR) Mekhanika Kompozitnykh Materialov, Mar.-Apr. 1982, p. 301-306. In Russian. refs

The energy storage capacity of filament-wound composite structures, such as rings, disks, and shells, is estimated using energy relationships derived from equilibrium equations. It is found that uniformly stressed structures have the highest energy storage capacity per specified mass. The maximum mass energy storage capacity is shown to be equal to one half of the specific material strength and is achieved in a thin ring. V.L.

A82-31841

**VIBRATING ZINC ELECTRODES IN NI/ZN BATTERIES**

M.-B. LIU, G. M. COOK, N. P. YAO (Argonne National Laboratory, Argonne, IL), and J. R. SELMAN (Illinois Institute of Technology, Chicago, IL) Electrochemical Society, Journal, vol. 129, May 1982, p. 913-920. Research supported by the U.S. Department of Energy. refs

It is noted that, in electrochemical processes where diffusion is rate controlling, the use of vibrating electrodes may result in an increase in the average mass transfer rate. The mechanism for this increase is that vibration changes the pattern of free convective flow developed during the process into a different flow pattern. Four models for the mass transfer enhancement are discussed and modified. An analysis is given of vibrating zinc electrodes in Ni/Zn batteries. The analysis comprises fluid dynamics, mass transfer, and electrochemical deposition phenomena. Consideration is also given to three types of fluid flows. The first, free-convective flow, is induced through the difference in the electrolyte density near the electrode and in the bulk. The other two, which are induced by the vibration of the zinc electrodes, are a periodic flow consisting of an oscillatory bulk flow and an oscillatory boundary flow, and a steady streaming near the upper and lower edges of the electrodes. A calculation is made of the mass-transfer coefficients of zincate and hydroxide ions. The morphology of the electrochemical deposition of zinc from alkaline zincate solution is related to ion-surface interactions. C.R.

A82-31869#

**SOME THERMOPHYSICAL PROPERTIES OF PARAFFIN WAX AS A THERMAL STORAGE MEDIUM**

A. HAJI-SHEIKH, J. EFTEKHAR, and D. Y. S. LOU (Texas, University, Arlington, TX) American Institute of Aeronautics and Astronautics and American Society of Mechanical Engineers, Joint Thermophysics, Fluids, Plasma and Heat Transfer Conference, 3rd, St. Louis, MO, June 7-11, 1982, AIAA 7 p. Research supported by the University of Texas. refs (AIAA PAPER 82-0846)

An experimental study is conducted to determine the suitability of paraffin wax SUNTECH P116 as a phase change material for storage of thermal energy. Certain temperature dependent thermophysical properties in the neighborhood of the melting point useful for this study, but not adequately available in the literature, are measured. They include thermal conductivity, density, thermal expansion coefficient, and viscosity. It is observed that the thermal conductivity of paraffin wax, in solid phase, is not a monotonic function of temperature as reported in the literature. Other thermophysical properties of the liquid phase measured vary monotonically with temperature. (Author)

A82-32373

**A NEW TECHNIQUE FOR DETERMINING BATTERY INTERNAL RESISTANCE - STUDIES ON LECLANCHE CELLS**

J. A. HAMILTON (Commonwealth Scientific and Industrial Research Organization, Institute of Earth Resources, Port Melbourne, Australia) Journal of Power Sources, vol. 7, Mar. 1982, p. 267-273. refs

A new technique for determining the internal resistance of batteries (and fuel cells) is described. The measuring circuit employs recently released VMOS field-effect transistors. The measurements do not require a storage or differential-input oscilloscope, and they can be performed in situ during battery discharge. The determination is similar to the constant-current, square-wave technique but is easier to use and does not rely on the use of approximations. Batteries can be tested without significant discharge because the mark-to-space ratio of the discharge pulse can be 0.1 percent. Data obtained on Leclanche cells using this technique are presented, showing the variation of internal resistance with discharge current and temperature. (Author)

A82-35230

**TRANSIT BUS PROPULSION EMPLOYING FLYWHEEL ENERGY STORAGE**

L. J. LAWSON (Garrett AiResearch Manufacturing Co., Torrance, CA) Journal of Advanced Transportation, vol. 16, Spring 1982, p. 87-101. refs

A Flywheel Energy Storage System (FESS) concept is described for application to urban transit buses which undergo recharging at route intervals of 3-5 miles. A detailed description is given of the composite flywheel rotor and the synchronous induction motor by which the flywheel is both recharged and discharged, functioning as a generator for the powering of a traction motor that drives the rear axle of the bus in the discharge mode. The development of an automatic collector and enroute charging technique is expected to obviate an otherwise necessary delay of 90 sec for recharging. A technical review of FESS characteristics has demonstrated the feasibility of retrofit installation into the buses of three of the five manufacturers consulted on this possibility. Attention is given to production and life cycle costs, based on a product life of ten years. O.C.

## 07 ENERGY STORAGE

**A82-35488#**

### **ENERGY STORAGE OPTIONS FOR HARNESSING WIND ENERGY**

R. RAMAKUMAR (Oklahoma State University, Stillwater, OK) American Society of Mechanical Engineers, Energy-Sources Technology Conference and Exhibition, New Orleans, LA, Mar. 7-10, 1982, 8 p. Research supported by the Oklahoma State University. refs

(ASME PAPER 82-PET-9) MEMBERS, \$2.00; NONMEMBERS, \$4.00

The inherent variability of the wind energy resource necessitates either an energy storage and reconversion system or a back-up unit to supply customers 'on demand'. A brief survey of the technical aspects of the various energy storage and reconversion options proposed for use with wind energy conversion systems is presented. Energy can be stored in mechanical, chemical, thermal, or electrical form. The schemes discussed include hydrofiring, compressed air, flywheels, hydrogen, secondary batteries, and thermal storage. (Author)

**A82-35525**

### **NEW PERSPECTIVES FOR KINETIC ENERGY STORAGE**

J.-P. BARTHELEMY (Societe Nationale Industrielle Aerospatiale, Les Mureaux, Yvelines, France) In: Energy conservation and thermal insulation. Chichester, Sussex, England, John Wiley and Sons, Ltd., 1981, p. 689-698.

Research on flywheels has produced fully integrated systems comprising a rotor, magnetic suspension, a motor-generator, and associated electronics. This makes it possible to introduce energy in electric form, store it in kinetic form, and recover it in electric form, the wheel being placed in a vacuum container for ground operations. A description is given of magnetic bearings and associated subsystems, with attention given to the passive permanent-magnet radial bearings, active electromagnetic axial bearing, axial servoloop, radial dampers, motor, emergency bearings, and electronics. It is shown that the main functional hardware can be adapted to ground applications without significant new developments for a range below 3 kW in power and 1 kWh in deliverable energy. Here, no special rooms or large surfaces are needed. Because of the inherent reliability of magnetic suspension, no maintenance is necessary. C.R.

**A82-36256**

### **NEW DEVELOPMENTS IN BATTERY TECHNOLOGY**

J. GRAY (Chloride Group, Ltd., London, England) Endeavour, vol. 6, no. 2, 1982, p. 78-82.

Practical, high energy density alternatives to the lead-acid battery are considered for both vehicular and utility load-leveling use, in view of year 2000 potential markets. After demonstrating the high costs and low energy densities and life cycles of lead/acid, nickel/iron and nickel/zinc systems, as well as batteries using gaseous electrodes such as the nickel/hydrogen system employed by communication satellites and those taking advantage of light metals like lithium and sodium, a description is given of the design features and operational characteristics of the sodium/sulfur battery. Attention is given to both internal and external sodium volume battery configurations, both of which employ beta alumina as a solid electrolyte with high sodium ion conductivity, and molten sodium and sulfur at 350 C. It is the thermal insulation of the sodium/sulfur battery that makes its application to electric vehicles difficult, despite a very high energy density. O.C.

**A82-36317**

### **AN INNOVATION WHICH COMES FROM SPACE - KINETIC ENERGY STORAGE [UNE INNOVATION QUI VIENT DE L'ESPACE - LE STOCKAGE CINETIQUE D'ENERGIE]**

J.-P. BARTHELEMY (Societe Nationale Industrielle Aerospatiale, Les Mureaux, Yvelines, France) La Recherche, vol. 12, Oct. 1981, p. 1162-1164. In French.

The potential ground-based applications of the technology of energy storage in a rotating flywheel, which was developed for use in satellites, are discussed. Problems of the conventional flywheel as used in satellite energy storage systems are identified,

including limited storage capacity and losses due to wear, limited life and low autonomy, and solutions offered by the use of composite materials on the one hand and magnetic suspension are pointed out. The design of a kinetic energy battery making use of magnetic levitation and currently undergoing tests as a reserve energy supply for a rural telephone system is then presented, and the operational advantages of such a system with respect to an electrochemical cell are pointed out. A.L.W.

**A82-37076#**

### **COMPOSITES IN ENERGY GENERATION AND STORAGE SYSTEMS - AN OVERVIEW**

R. W. FULMER (Owens Corning Fiberglas Corp., Fiberglas Composites and Equipment Marketing Div., Toledo, OH) In: Reinforced Plastics/Composites Institute, Annual Conference, 36th, Washington, DC, February 16-20, 1981, Preprints. New York, Society of the Plastics Industry, Inc., 1981 (Session 22-A). 8 p. refs

Applications of glass-fiber reinforced composites (GER) in renewable and high-efficiency energy systems which are being developed to replace interim, long-term unacceptable energy sources such as foreign oil are reviewed. GFR are noted to have design flexibility, high strength, and low cost, as well as featuring a choice of fiber orientation and type of reinforcement. Blades, hub covers, nacelles, and towers for large and small WECS are being fabricated and tested and are displaying satisfactory strength, resistance to corrosion and catastrophic failure, impact tolerance, and light weight. Promising results have also been shown in the use of GFR as flywheel material for kinetic energy storage in conjunction with solar and wind electric systems, in electric cars, and as load levellers. Other applications are for heliostats, geothermal power plant pipes, dam-atoll tidal wave energy systems, and intake pipes for OTECs. M.S.K.

**N82-22498#** Rocketdyne, Canoga Park, Calif.

### **RPE-10 COMPOSITE FLYWHEEL TESTING Final Report**

B. R. GINSBURG 15 Jun. 1981 47 p refs Prepared for California Univ., Livermore. Lawrence Livermore Lab.

(Contract W-7405-ENG-48)

(UCRL-15379; RI-RD81-166) Avail: NTIS HC A03/MF A01

A final report on the technical efforts in testing an RPE-10 composite flywheel is presented. The RPE-10 composite flywheel (unit no. 2) designed and fabricated for vehicle use, was tested to a speed of 21,600 rpm, at which time the overwrap separated from the flywheel, terminating the test. The primary cause of failure was attributed to overheating in the test cell, causing a deterioration in material properties of the epoxy bond. The RPE-10 composite flywheel unit no. 1 was successfully tested without failure to 24,120 rpm. At this speed, the rotor stored over 2.0 kilowatt hours of kinetic energy. M.D.K.

**N82-22773#** Sargent and Lundy, Engineers, Chicago, Ill.

### **COMPRESSED-AIR ENERGY STORAGE: PRELIMINARY DESIGN AND SITE DEVELOPMENT PROGRAM IN AN AQUIFER.**

#### **VOLUME 3B: SITE SELECTION STUDY, PART 2 Final Report**

W. C. WATKES 31 Jul. 1981 24 p refs Sponsod by EPRI

Prepared in cooperation with Public Service Co. of Indiana, Inc.

(Contract DE-AC02-78ET-29232; ET-78-C-01-2159; EPRI PROJ.

RP-1081-3)

(DE82-000674; DOE/ET-29232/T4-VOL-3B) Avail: NTIS HC A02/MF A01

Fourteen sites considered to have potential for development with a 1000 MW compressed air energy storage (CAES) plant were identified by the Illinois State Geological Survey (ISGS) and the Indiana Geological Survey (IGS). The relative desirability of developing each of these sites was evaluated from the standpoints of geology, economics, air quality/meteorology, cultural resources, and ecology. Preliminary site layouts were developed for each of the 14 sites. Sites that were found to be incapable of supporting a 1000 MW plant, or that would require more than 2000 air injection-withdrawal wells to do so, were eliminated from consideration. The seven remaining top-ranked sites were then selected for further study. T.M.

**N82-22789#** Institut fuer Kerntechnik und Energiewandlung e.V., Stuttgart (West Germany).

**LATENT HEAT THERMAL ENERGY STORAGE: DETERMINATION OF PROPERTIES OF STORAGE MEDIA AND DEVELOPMENT OF A NEW TRANSFER SYSTEM Final Report, Jun. 1980**

A. ABHAT, S. ABOUL-ENEIN, and N. A. MALATIDIS Bonn Bundesministerium fuer Forschung und Technologie Jan. 1982 193 p refs In GERMAN; ENGLISH summary Sponsored by Bundesministerium fuer Forschung und Technologie (BMFT-FB-T-82-016; ISSN-0340-7608) Avail: NTIS HC A09/MF A01; Fachinformationszentrum, Karlsruhe, West Germany DM 34,80

A latent heat storage system for low temperature solar heating applications was developed. Latent heat storage materials were studied and a heat exchanger design was evaluated. Thermophysical properties of 14 organic and inorganic heat storage materials, including 5 inexpensive commercial paraffins, 2 fatty acids, and 5 salt hydrates, were measured with a precision differential scanning calorimeter. Data pertaining to phase transition temperature, enthalpy and, specific heat of the heat storage materials in solid and liquid phases were taken. The influence of thermal cycling on the melting and freezing behavior of the materials and on changes in thermophysical properties was analyzed. A heat exchanger with finned annulus heat exchanger elements was investigated. Tests were performed, using two laboratory models that employed a paraffin, two fatty acids and one salt hydrate as heat storage materials. Author (ESA)

**N82-22843#** Technische Universitaet, Brunswick (West Germany). Inst. fuer Physikalische Chemie.

**INVESTIGATIONS TO PREDICT AND REDUCE THE EVAPORATION RATE OF THE RESIDUAL BRINE IN SALT CAVERNS USED FOR GAS STORAGE Final Report, Dec. 1980**

H. J. PETRICK, H. K. CAMMenga, and D. HERZ Bonn Bundesministerium fuer Forschung und Technologie Dec. 1981 42 p refs In GERMAN; ENGLISH summary Sponsored by Bundesministerium fuer Forschung und Technologie (BMFT-FB-T-81-226; ISSN-0340-7608) Avail: NTIS HC A03/MF A01; Fachinformationszentrum, Karlsruhe, West Germany DM 8,80

Tensides were tested for their ability to reduce the evaporation rate of residual brine in salt caverns used for gas storage. Fatty alcohols with more than 20 CH<sub>2</sub> groups and perfluorinated alcohols with more than 12 CF<sub>2</sub> groups prove especially useful. The formation of a solid salt crust on the initially free brine surface is due to the incorporation of alkaline Earth ions. After its completion, the solid salt crust enormously reduces the evaporation rate of the underlying brine. It is found that by the use of different tensides, crust formation can be either enhanced or retarded at will.

Author (ESA)

**N82-23735#** Public Service Co. of Indiana, Plainfield.

**COMPRESSED-AIR ENERGY STORAGE: PRELIMINARY DESIGN AND SITE DEVELOPMENT PROGRAM IN AN AQUIFER. VOLUME 1: EXECUTIVE SUMMARY Final Report**

T. W. MCCAFFERTY, W. C. WALKER, and J. S. BONK 31 Jul. 1981 133 p Prepared in cooperation with Sargent and Lundy, Engineers and Westinghouse Electric Corp., Concordville, Pa. 9 Vol. (Contract DE-AC02-78ET-29232; ET-78-C-01-2159; EPRI PROJ. RP-1081-3) (DE82-000270; DOE/ET-29232/T4-VOL-1) Avail: NTIS HC A07/MF A01

The behavior and suitability of an aquifer-based compressed air energy storage (CAES) facility were investigated. The project was part of a five-phase program to promote compressed air energy storage and underground pumped hydro in the United States. The background, project organization, and summarization of all project work are provided. T.M.

**N82-23736#** Public Service Co. of Indiana, Plainfield.

**COMPRESSED-AIR ENERGY STORAGE: PRELIMINARY DESIGN AND SITE DEVELOPMENT PROGRAM IN AN AQUIFER. VOLUME 3A: SITE SELECTION STUDY, PART 1 Final Report** W. C. WALKER 31 Jul. 1981 121 p refs Prepared in cooperation with Sargent and Lundy, Engineers 9 Vol. (Contract DE-AC02-78ET-29232; ET-78-C-01-2159; EPRI PROJ. RP-1081-3) (DE82-000675; DOE/ET-29232/T4-VOL-3A) Avail: NTIS HC A06/MF A01

A preferred ranking for aquifer sites potentially capable of supporting a CAES facility is provided. The study area that was investigated for possible aquifer storage sites comprises roughly the Illinois and Indiana portions of the geologic structure known as the Illinois Basin. Sites in Illinois and Indiana adjacent to the Illinois Basin that appeared suitable geologically were also investigated. Potential sites in this area were identified by the Illinois State Geological Survey (ISGS) and the Indiana Geological Survey (IGS). T.M.

**N82-23737#** Public Service Co. of Indiana, Plainfield.

**COMPRESSED-AIR ENERGY STORAGE: PRELIMINARY DESIGN AND SITE DEVELOPMENT PROGRAM IN AQUIFER. VOLUME 6: BALANCE OF PLANT DESIGN Final Report**

31 Jul. 1981 534 p refs Prepared in cooperation with Sargent and Lundy, Engineers 9 Vol. (Contract DE-AC02-78ET-29232; ET-78-C-01-2159; EPRI PROJ. RP-1081-3) (DE82-000670; DOE/ET-29232/T4-VOL-6) Avail: NTIS HC A23/MF A01

The behavior and suitability of an aquifer-based compressed-air energy storage (CAES) plant was studied. Methodologies and preliminary design procedures for developing, designing, constructing, and operating a CAES facility utilizing an aquifer storage formation were established earlier. The balance of plant design considerations for a CAES plant are given. The design of the above ground facilities including well locations, fuel oil storage, switchyard, facility access, plant and equipment arrangement, and process flow diagrams are discussed. DOE

**N82-23738#** Public Service Co. of Indiana, Plainfield.

**COMPRESSED-AIR ENERGY STORAGE: PRELIMINARY DESIGN AND SITE DEVELOPMENT PROGRAM IN AN AQUIFER. VOLUME 7: ENVIRONMENTAL, SAFETY, AND LICENSING CONSIDERATIONS Final Report**

31 Jul. 1981 364 p refs Prepared in cooperation with Sargent and Lundy, Engineers 9 Vol. (Contract DE-AC02-78ET-29232; ET-78-C-01-2159; EPRI PROJ. RP-1081-3) (DE82-000669; DOE/ET-29232/T4-VOL-7) Avail: NTIS HC A16/MF A01

The behavior and suitability of aquifers as compressed-air energy storage (CAES) sites was studied. The probability, severity, and recommended control measures for the environmental and safety impacts that could result from the construction and operation of a CAES facility are described. The permits and approvals that would be required and the time estimated for their acquisition are also described. DOE

**N82-23739#** Public Service Co. of Indiana, Plainfield.

**COMPRESSED-AIR ENERGY STORAGE: PRELIMINARY DESIGN AND SITE DEVELOPMENT PROGRAM IN AN AQUIFER. VOLUME 8: AQUIFER FLOW CODE SIMULATION Final Report**

D. L. AYERS 31 Jul. 1981 301 p refs Prepared in cooperation with Westinghouse Electric Corp., West Lafayette, Ind. 9 Vol. (Contract DE-AC02-78ET-29232; ET-78-C-01-2159; EPRI PROJ. RP-1081-3) (DE82-000668; DOE/ET-29232/T4-VOL-8) Avail: NTIS HC A10/MF A01

The behavior and suitability of an aquifer-based compressed air energy storage (CAES) plant were investigated. Methodologies and preliminary design procedures for developing, designing,

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constructing, and operating a CAES facility utilizing an aquifer storage formation were established. Descriptions, development, and results from a one-dimensional air flow computer model, two-dimensional air flow computer model, and a manifold air flow/pressure loss model are provided. These models are analytic tools used to predict aquifer performance and CAES system analysis. DOE

**N82-23740#** Public Service Co. of Indiana, Plainfield.  
**COMPRESSED-AIR ENERGY STORAGE: PRELIMINARY DESIGN AND SITE DEVELOPMENT PROGRAM IN AN AQUIFER. VOLUME 9: COST ESTIMATE AND SCHEDULE Final Report**  
31 Jul. 1981 115 p refs Prepared in cooperation with Sargent and Lundy, Engineers 9 Vol.  
(Contract DE-AC02-78ET-29232; ET-78-C-01-2159; EPRI PROJ. RP-1081-3)  
(DE82-000667; DOE/ET-29232/T4-VOL-9) Avail: NTIS HC A06/MF A01

The engineering and construction schedule, facilities capital cost estimate and corresponding cash flow requirements relative to the construction of a compressed-air energy storage facility on an aquifer site is discussed. DOE

**N82-23753#** Acres American, Inc., Buffalo, N.Y.  
**PRELIMINARY DESIGN STUDY OF UNDERGROUND PUMPED HYDRO AND COMPRESSED-AIR ENERGY STORAGE IN HARD ROCK. VOLUME 8: DESIGN APPROACHES. UPH, APPENDIX D: POWER PLANT Final Report**  
Jun. 1981 607 p Sponsored in part by Electric Power Research Inst. Prepared for Potomac Electric Power Co., Washington, D.C.  
(Contract DE-AC02-77ET-28013; EPRI PROJ. 1081-1)  
(DE82-003075; EPRI-EM-1589-VOL-8-APP-D; DOE/ET-5047/8.D) Avail: NTIS HC A99/MF A01

Studies were undertaken to determine power plant arrangements for a single stage reversible pump turbine two step underground pumped hydro (UPH) installation and for a multi-stage reversible pump turbine single step (MSRPT) UPH installation. Arrangements consist of: the underground powerhouses; transformer galleries; associated mechanical and electrical equipment; the administration and control building; hoist head frames; the access; draft tube and bus tunnels; and the switchyard. Primary considerations including the number and size of pump turbine and motor generator units, starting methods, transformers, high voltage connections, geotechnical and construction aspects and safety were studied. A feasibility analysis to minimize costs was conducted. The study led to the selection of suitable equipment and layouts for the powerhouses, transformer galleries, and associated facilities. The material presented and also the cost estimates are based on the requirements for a 2000 MW plant providing 20,000 MWh of storage with a nominal head of 4600 ft. DOE

**N82-23764#** Massachusetts Inst. of Tech., Cambridge.  
**PHOTOCHEMICAL ENERGY STORAGE: STUDIES OF INORGANIC PHOTOASSISTANCE AGENTS Progress Report, 17 Dec. 1980 - 14 Sep. 1981**  
M. S. WRIGHTON Sep. 1981 31 p refs  
(Contract DE-AS02-76ER-04178)  
(DE82-000403; DOE/ER-04178/5) Avail: NTIS HC A03/MF A01

Work concerning the use of certain n- and p-type semiconductors, including Si, InP, WS<sub>2</sub>, TiO<sub>2</sub>, and SrTiO<sub>3</sub>, as photoelectrode materials in photoelectrochemical cells for optical energy conversion is reported. Additionally, intrinsic a-Si:H on a stainless steel substrate was characterized where the contact to the stainless steel is a thin, heavily doped n-type layer resulting in an ohmic contact near the conduction band. Study of p-type Si bearing a redox polymer/Pt(O) or Pd(O) catalyst system was ongoing and improvements in photoelectrochemical H<sub>2</sub> generation via surface catalysis were demonstrated. Highlights of the accomplishments so far are: (1) the demonstration that n-type WS<sub>2</sub>-based photoelectrochemical cells can be used to sustain the uphill conversion of SO<sub>2</sub> and H<sub>2</sub>O to H<sub>2</sub>SO<sub>4</sub> and H<sub>2</sub> in 50%

by weight H<sub>2</sub>SO<sub>4</sub>; (2) establishment of the behavior of photoconductor (a-Si:H) electrodes in contact with liquid electrolytes. DOE

**N82-23771#** Acres American, Inc., Buffalo, N.Y.  
**PRELIMINARY DESIGN STUDY OF UNDERGROUND PUMPED HYDRO AND COMPRESSED-AIR ENERGY STORAGE IN HARD ROCK. VOLUME 11: PLANT DESIGN. UPH Final Report**  
Jun. 1981 379 p refs Prepared in cooperation with Potomac Electric Power Co. 13 Vol.  
(Contract DE-AC02-77ET-28012; EPRI PROJ. 1981-1)  
(DE82-000918; EPRI-EM-1589-VOL-11; DOE/ET-5047/11) Avail: NTIS HC A17/MF A01

The plant design for an underground pumped hydroelectric (UPH) storage facility having maximum generating capacity of 2000 MW and energy storage capacity of 20,000 MWh at a nominal head of 5000 ft. is presented. The UPH facility is a two step configuration with single-stage reversible pump-turbines, each step consisting of a 1000 MW plant at a nominal head of 2500 ft. The surface facilities and upper reservoir, shafts and hoists, penstocks and hydraulic tunnels, powerhouses, and intermediate and lower reservoirs are described. Details of the power plant electrical and mechanical equipment, including pump-turbine and motor-generator units, are given. The development of the site is outlined together with the construction methods and schedule. The cost estimates and a cost-risk analysis are presented. Plant operation, including unit operation, two-step operation, plant efficiency, and availability, is outlined. T. M.

**N82-23781#** Applied Physics Lab., Johns Hopkins Univ., Laurel, Md.

**ENERGY PROGRAMS AT THE JOHN HOPKINS UNIVERSITY APPLIED PHYSICS LABORATORY Quarterly Report, Apr. - Jun. 1981**

Jul. 1981 37 p refs Sponsored in part by DOE  
(PB82-126699; JHU/APL/EQR/81-2) Avail: NTIS HC A03/MF A01 CSCL 10A

Efforts in geothermal energy development planning and technical assistance, energy conversion and storage techniques, siting of critical facilities, magnetic fusion and mathematical models of fires are briefly described. GRA

**N82-24652#** Courtesy Associates, Inc., Washington, D.C.  
**PROCEEDINGS OF THE DOE THERMAL AND CHEMICAL STORAGE ANNUAL CONTRACTOR'S REVIEW MEETING**  
Mar. 1981 361 p refs Meeting held at McLean, Va., 14-16 Oct. 1980 Prepared for Brookhaven National Lab.  
(Contract DE-AC02-76CH-00016)  
(CONF-801055) Avail: NTIS HC A16/MF A01

Overviews of Thermal Energy Storage and Chemical/Hydrogen Energy Storage Programs are presented. The progress and accomplishments of each subcontractor, program management and interested researchers from industry, academia, and government are summarized.

**N82-24653#** Department of Energy, Washington, D. C. Thermal and Chemical Storage Branch.  
**OVERVIEW OF THE THERMAL ENERGY STORAGE (TES) PROGRAM**

M. GUREVICH /n Courtesy Associates, Inc. Proc. of the DOE Thermal and Chem. Storage Ann. Contractor's Rev. Meeting p 1-2 Mar. 1981  
Avail: NTIS HC A16/MF A01

The program promotes energy savings and fuel substitution by developing and helping to commercialize technologies for storing heat or cold, with short investment payback periods as a cost goal. The sources of energy include industrial and utility waste heat as well as primary sources such as solar, geothermal, nuclear and fossil fuels. The primary source of 'cold' for seasonal storage is winter chilled air. The program emphasizes near-term (1980's) approaches to energy conservation and displacement of natural gas and oil. It also provides for development of technologies which will allow use of renewable resources such as solar-thermal energy

during the mid-term (1990's) and advanced energy storage and transport techniques for the far-term (beyond 2000). T.M.

**N82-24654#** Oak Ridge National Lab., Tenn.

**ORNL THERMAL ENERGY STORAGE PROGRAM OVERVIEW**

J. F. MARTIN /In Courtesy Associates, Inc. Proc. of the DOE Thermal and Chem. Storage Ann. Contractor's Rev. Meeting p 3-10 Mar. 1981 refs

Avail: NTIS HC A16/MF A01

Development of thermal energy storage (TES) technologies and subsystems is relevant to national energy objectives in energy conservation and in the deployment of new energy sources. Oak Ridge National Laboratory (ORNL) acts as a Lead Technical Laboratory in managing for DOE-STOR those elements of the program dealing with building heating and cooling, and industrial applications. The scope of ORNL activity in these two activities is described, and a summary of each of the in-house and subcontracted projects current or anticipated for the next fiscal year are presented. The major thrust of each of the elements of the ORNL program is given. Author

**N82-24655#** New York State Energy Research and Development Authority, Albany.

**DESIGN AND DEMONSTRATION OF A STORAGE-ASSISTED AIR CONDITIONING SYSTEM**

J. E. RIZZUTO /In Courtesy Associates, Inc. Proc. of the DOE Thermal and Chem. Storage Ann. Contractor's Rev. Meeting p 11-14 Mar. 1981

Avail: NTIS HC A16/MF A01

The system is a peak-shaving system designed to provide a leveled air conditioning load. The system also requires minimum air conditioner and thermal storage capacity. The storage-assisted air conditioning system uses a Glauber's salt-based phase change material in sausage like containers called CHUBS. The CHUBS are two (2) inches in diameter and 20 inches long. They are stacked in modules of 64 CHUBS which are appropriately spaced and oriented in the storage system so that air may pass perpendicular to the long axis of the CHUBS. The phase change material, has a thermal storage capacity in the range of 45 to 50 Btu/lb and a transition temperature of approximately 55 F. T.M.

**N82-24656#** Argonne National Lab., Ill.

**EXPERIMENTAL EVALUATION OF THERMAL ENERGY STORAGE Status Report**

H. N. HERSH /In Courtesy Associates, Inc. Proc. of the DOE Thermal and Chem. Storage Ann. Contractor's Rev. Meeting p 15-17 Mar. 1981

Avail: NTIS HC A16/MF A01

Thermal energy storage (TES) for space heating is a load management technique that is successfully used in Europe. Results from the ANL assessment of energy storage technologies indicated that customer owned TES units of the type used in Europe could provide a cost-effective means for utility load management in the U.S. It is only necessary, therefore, that the technical and economic viability of this technology be examined under the U.S. climatic, institutional and other conditions. T.M.

**N82-24662#** Purdue Univ., Lafayette, Ind. School of Mechanical Engineering.

**THERMAL ENERGY STORAGE TESTING FACILITY**

R. J. SCHOENHALS, C. P. LIN, H. F. KUEHLERT, and S. H. ANDERSON /In Courtesy Associates, Inc. Proc. of the DOE Thermal and Chem. Storage Ann. Contractor's Rev. Meeting p 33-36 Mar. 1981 refs

(Contract W-31-109-38-4666)

Avail: NTIS HC A16/MF A01

Development of a prototype testing facility for performance evaluation of electrically heated thermal energy storage units is described. Laboratory apparatus and test procedures were evaluated by means of measurements and analysis. A 30kW central unit and several smaller individual room-size units were tested. T.M.

**N82-24665#** Tennessee Univ., Knoxville. Dept. of Mechanical and Aerospace Engineering.

**PERFORMANCE OF STRATIFIED THERMAL STORAGE SYSTEM FOR OLIVER SPRINGS ELEMENTARY SCHOOL Progress Report**

R. L. REID and A. F. G. BEDINGER /In Courtesy Associates, Inc. Proc. of the DOE Thermal and Chem. Storage Ann. Contractor's Rev. Meeting p 44-46 Mar. 1981 refs

Avail: NTIS HC A16/MF A01

A progress report on the performance of a stratified thermal storage system coupled with a heat recovery refrigeration machine designed to provide space heating, cooling, and service water heating is presented. Water storage tanks utilizing a flexible membrane to resist temperature blending will be used as the thermal storage element. The two design goals of the heat recovery and thermal energy storage system are: (1) to minimize the need to purchase energy for space heating and cooling and water heating, and (2) to minimize electrical demand. An automatic data acquisition system will be used for system performance data gathering. M.D.K.

**N82-24667#** Midwest Research Inst., Golden, Colo. Solar Energy Research Inst.

**DIRECT CONTACT HEAT TRANSFER FOR THERMAL ENERGY STORAGE**

J. D. WRIGHT /In Courtesy Associates, Inc. Proc. of the DOE Thermal and Chem. Storage Ann. Contractor's Rev. Meeting p 50-53 Mar. 1982 refs

Avail: NTIS HC A16/MF A01

Direct contact heat exchange offers the potential for increased efficiency and lower heat transfer costs in a variety of thermal energy storage systems. SERI models of direct contact heat transfer based on literature information identified dispersed phase drop size, the mechanism of heat transfer within the drop, and dispersed phase holdup as the parameters controlling direct contact system performance. Tests were defined and equipment constructed to provide independent determination of drop size, heat transfer mechanism, and hold up. Further experiments are needed to conclusively determine whether the salt in a salt hydrate melt acts to block internal circulation. The potential of low temperature oil/salt hydrate latent heat storage systems is being evaluated in the laboratory. M.D.K.

**N82-24668#** Midwest Research Inst., Golden, Colo. Solar Energy Research Inst.

**SYSTEMS ANALYSIS OF THERMAL STORAGE**

R. J. COPELAND /In Courtesy Associates, Inc. Proc. of the DOE Thermal and Chem. Storage Ann. Contractor's Rev. Meeting p 54-57 Mar. 1981 refs

Avail: NTIS HC A16/MF A01

During FY80 analyses were conducted on thermal storage concepts for solar thermal applications. These studies include both estimates of the obtainable costs of thermal storage concepts and their worth to a user (i.e., value). Based on obtainable costs and performance, promising thermal storage concepts are being identified. A preliminary screening was completed in FY80 and a more in-depth study was initiated. Value studies are being conducted to establish cost goals. A ranking of storage concepts based on value in solar thermal electric plants was conducted for both diurnal and long duration applications. Ground mounted thermal storage concepts for a parabolic dish/Stirling system are also being evaluated. Author

**N82-24670#** Institute of Gas Technology, Chicago, Ill.

**HIGH-TEMPERATURE MOLTEN SALT THERMAL ENERGY STORAGE SYSTEMS FOR SOLAR APPLICATIONS**

R. J. PETRI and T. D. CLAAR /In Courtesy Associates, Inc. Proc. of the DOE Thermal and Chem. Storage Ann. Contractor's Rev. Meeting p 60-64 Mar. 1982 refs

Avail: NTIS HC A16/MF A01

A plan for the selection and testing of latent-heat alkali and alkaline earth carbonate storage salts, containment materials, and thermal conductivity enhancement (TCE) materials for use in

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high-temperature (704 to 871 C) thermal energy storage systems utilizing advanced solar-thermal power generation concepts is described. Screening of candidate salt/containment/TCE materials combinations will be performed. Results of these compatibility tests will lead to the selection of materials combinations that meet anticipated solar power system requirements. Needs for more reliable thermophysical and transport property data will be identified and measurements will then be performed on these salts to support the scale-up of solar-thermal TES subsystems. M.D.K.

**N82-24671#** Grumman Aerospace Corp., Bethpage, N.Y.  
**ACTIVE HEAT EXCHANGE: SYSTEM DEVELOPMENT FOR LATENT HEAT THERMAL ENERGY STORAGE**

J. ALARIO and R. HASLETT /In Courtesy Associates, Inc. Proc. of the DOE Thermal and Chem. Storage Ann. Contractor's Rev. Meeting p 65-67 Mar. 1981  
Avail: NTIS HC A16/MF A01

An active heat exchange method in a latent heat (salt) thermal energy storage system that prevents a low conductivity solid salt layer from forming on heat transfer surfaces was developed. An evaluation of suitable media with melting points in the temperature range of interest (250 to 400 C) limited the candidates to molten salts from the chloride, hydroxide, and nitrate families, based on high storage capacity, good corrosion characteristics, and availability in large quantities at reasonable cost. The specific salt recommended for laboratory tests was a chloride eutectic (20.5KCl, 24.5NaCl, 55.0MgCl<sub>2</sub> percent by wt.), with a nominal melting point of 385 C. Author

**N82-24672#** Naval Research Lab., Washington, D. C.  
**THE 1980 REPORT ON NRL ENERGY STORAGE PROGRAM**  
T. A. CHUBB, J. J. NEMECEK, D. E. SIMMONS, and R. J. VEITH /In Courtesy Associates, Inc. Proc. of the DOE Thermal and Chem. Storage Ann. Contractor's Rev. Meeting p 68-72 Mar. 1981  
Avail: NTIS HC A16/MF A01

The development of a means for bulk storage of energy in a form capable of providing demand sensitive steam, heat, or cooling is described. Salt eutectic systems availability and costs-of-salts, progress on the 2 MWhr energy storage boiler tank under construction at NRL, and major elements of storage system costs for this 2 MWhr tank which employs a heat transfer fluid are discussed. A radiation coupled energy storage tank concept is also discussed. Author

**N82-24674#** TRW, Inc., Oak Ridge, Tenn.  
**THERMAL ENERGY STORAGE FOR RESIDENTIAL ENERGY CONSERVATION**

D. GOLDENBERG /In Courtesy Associates, Inc. Proc. of the DOE Thermal and Chem. Storage Ann. Contractor's Rev. Meeting p 79-83 Mar. 1981 refs  
Avail: NTIS HC A16/MF A01

The potential for conservation of oil and gas was evaluated for thermal energy storage applications involving waste heat recovery and passive solar systems for houses that have gas- or oil-fired furnaces. A waste heat recovery device using pebbles as the TES medium increases furnace seasonal efficiency to 95%. Passive solar system performance was estimated from work sponsored by the Department of Energy. Potential market sizes and penetrations were evaluated by region to determine national oil and gas savings. The total oil and gas savings for the year 2000 were estimated to be 0.22 quads/year for the furnace waste heat recovery device and 0.10 quads/year for passive solar systems installed in houses heated by gas or oil furnaces. Author

**N82-24680#** Sandia Labs., Albuquerque, N. Mex. Fluid Mechanics and Heat Transfer Div.

**STATUS REPORT OF THERMOCLINE THERMAL ENERGY STORAGE STUDIES AT SANDIA NATIONAL LABORATORIES**

R. J. GROSS and R. W. HARRIGAN /In Courtesy Associates, Inc. Proc. of the DOE Thermal and Chem. Storage Ann. Contractor's Rev. Meeting p 104-108 Mar. 1981 refs  
Avail: NTIS HC A16/MF A01

The thermocline thermal energy storage concept was evaluated to fulfill the needs of solar thermal energy systems. A 1200 gallon engineering prototype tank was constructed and tested. Component development and computer code verification were initiated. Analytical modeling, both one and two-dimensional was also initiated. The feasibility of thermocline storage and the maximum expected performance, in both an engineering and economic sense, are to be determined. M.D.K.

**N82-24683#** General Electric Co., Evendale, Ohio.  
**STORAGE REQUIREMENTS DEFINITION AND SRE DESIGN FOR DISH STIRLING SYSTEMS**

W. F. ZIMMERMAN, L. E. STACY, and G. C. WESLING /In Courtesy Associates, Inc. Proc. of the DOE Thermal and Chem. Storage Ann. Contractor's Rev. Meeting p 118-122 Mar. 1981  
Avail: NTIS HC A16/MF A01

A direct dish Stirling solar receiver (DSSR) and a heat pipe solar receiver with TES (HPSR) are described. Cost effectiveness and thermal performance, analyzed minute by minute over one year of solar insolation are included. Using existing designs of these two receivers, parametric performance and cost studies to determine the influences of adding varying amounts of TES to the DSSR, and of providing fossil fuel combustion, and of varying the levels of TES in the HPSR are discussed. The thermal modeling of the two receivers was completed and the criteria and programming for the economic analysis were documented. Author

**N82-24684#** Ford Aerospace and Communications Corp., Newport Beach, Calif. Aeronutronic Div.  
**THERMAL ENERGY BUFFER STORAGE FOR THE SMALL COMMUNITY SOLAR THERMAL POWER EXPERIMENT**

R. E. POLZIEN /In Courtesy Associates, Inc. Proc. of the DOE Thermal and Chem. Storage Ann. Contractor's Rev. Meeting p 123-128 Mar. 1981 refs  
Avail: NTIS HC A16/MF A01

The application of a latent heat thermal energy buffer storage (TEBS) subsystem to the small community solar thermal power experiment (SCSE) is discussed. The SCSE consists of multiple point focusing distributed receiver (PFDR) power modules equipped with an organic Rankine cycle power conversion unit mounted at the focus of each paraboloidal concentrator. The objective of the TEBS is to minimize plant shutdowns during intermittent cloud coverages, thereby improving life expectancy of the major subsystems with attendant reduction in capital investment and maintenance costs. An SCSE plant performance model modified for operation with a TEBS system is used with time varying insolation to show that 70 to 80 percent of the potential engine shutdowns due to insolation dropout may be averted with the TEBS system. Results of preliminary design analyses of various TEBS concepts are discussed. Author

**N82-24685#** Rocket Research Corp., Redmond, Wash.  
**APPLICATION OF THERMAL ENERGY STORAGE TO PROCESS HEAT RECOVERY IN THE ALUMINUM INDUSTRY**

L. B. KATTER /In Courtesy Associates, Inc. Proc. of the DOE Thermal and Chem. Storage Ann. Contractor's Rev. Meeting p 129-132 Mar. 1981  
Avail: NTIS HC A16/MF A01

The economic viability and institutional compatibility of a district heating system that uses waste heat from an aluminum plant as the source of thermal energy are discussed. The project was designed to show how existing energy storage techniques can enhance the utility of low temperature waste heat streams. Author

**N82-24686\*#** Edde (Howard), Inc., Bellevue, Wash.  
**COLLECTION AND DISSEMINATION OF THERMAL ENERGY STORAGE SYSTEM INFORMATION FOR THE PULP AND PAPER INDUSTRY**

H. EDDE /In Courtesy Associates, Inc. Proc. of the DOE Thermal and Chem. Storage Ann. Contractor's Rev. Meeting p 133-136 Mar. 1981 refs

(Contract DEN3-190)

Avail: NTIS HC A16/MF A01 CSCL 10A

The collection and dissemination of thermal energy storage (TES) system technology for the pulp and paper industry with the intent of reducing fossil fuel usage is discussed. The study plan is described and a description presented of example TES systems.

Author

**N82-24687#** Heinz (H. J.) Co., Pittsburgh, Pa.  
**APPLICATIONS OF THERMAL ENERGY STORAGE TO WASTE HEAT RECOVERY IN THE FOOD PROCESSING INDUSTRY**

G. J. TREBILCOX and W. L. LUNDBERG (Westinghouse Electric Corp., Pittsburgh, Pa.) /In Courtesy Associates, Inc. Proc. of the DOE Thermal and Chem. Storage Ann. Contractor's Rev. Meeting p 137 Mar. 1981

(Contract EC-77-C-01-5002)

Avail: NTIS HC A16/MF A01

The canning segment of the food processing industry is a major energy user within that industry. Most of its energy demand is met by hot water and steam and those fluids, in addition to product cooling water, eventually flow from the processes as warm waste water. To minimize the possibility of product contamination, a large percentage of that waste water is sent directly to factory drains and sewer systems without being recycled and in many cases the thermal energy contained by the waste streams also goes unreclaimed and is lost from further use. Waste heat recovery in canning facilities can be performed economically using systems that employ thermal energy storage (TES). A project was proposed in which a demonstration waste heat recovery system, including a TES feature, would be designed, installed and operated.

Author

**N82-24688#** Burns and Roe, Inc., Oradell, N. J.  
**ONCE-THROUGH HEAT SUPPLY SYSTEM FOR CITY OF BELLINGHAM**

I. OLIKER /In Courtesy Associates, Inc. Proc. of the DOE Thermal and Chem. Storage Ann. Contractor's Rev. Meeting p 138-140 Mar. 1981 refs

Avail: NTIS HC A16/MF A01

Technical aspects of a once-through system are discussed. Waste heat utilization, space heating, and heat storage, are discussed.

N.W.

**N82-24691#** Rocket Research Corp., Redmond, Wash.  
**THE SULFURIC ACID/WATER CHEMICAL HEAT PUMP/ENERGY STORAGE PROGRAM**

E. C. CLARK, D. K. CARLSON, and O. M. MORGAN /In Courtesy Associates, Inc. Proc. of the DOE Thermal and Chem. Storage Ann. Contractor's Rev. Meeting p 150-153 Mar. 1981 refs

Avail: NTIS HC A16/MF A01

A large-scale verification test unit was designed which incorporates many commercial mass producible design features and materials. The nominal storage capacity is 1,000,000 Btu, with a power rating equal to 150,000 Btu/hr. An engineering model CHP/CES system was designed, fabricated, and tested closed loop with a nominal 25,000 Btu/hr charge and discharge rate and 150K to 300K Btu storage capacity, depending on the number of tanks. Preliminary testing of commercial grade acid plumbing and valves is complete with no equipment failures.

Author

**N82-25640\*#** Giner, Inc., Waltham, Mass.  
**REQUIREMENTS FOR OPTIMIZATION OF ELECTRODES AND ELECTROLYTE FOR THE IRON/CHROMIUM REDOX FLOW CELL Final Report**

V. JALAN, H. STARK, and J. GINER Sep. 1981 82 p refs (Contract DEN3-97; DE-AI04-80AL-12726)

(NASA-CR-165218; DOE/NASA/0097-80/1; NAS 1.26:165218)

Avail: NTIS HC A05/MF A01 CSCL 10C

Improved catalyzation techniques that included a pretreatment of carbon substrate and provided normalized carbon surface for uniform gold deposition were developed. This permits efficient use of different batches of carbon felt materials which initially vary significantly in their physical and surface chemical properties, as well as their electrochemical behavior. Further modification of gold impregnation technique gave the best performing electrodes. In addition to the linear sweep voltammetry, cyclic voltammetry was used to determine the effects of different activation procedures on the Cr(3)/Cr(2) Redox and H<sub>2</sub> evolution reactions. The roles of carbon, gold and lead in the overall Redox cycle are identified. The behavior of the electrodes at both normal battery operating potentials and more extreme potentials is discussed preparing efficient and stable electrodes for the energy storage battery is implicated.

E.A.K.

**N82-26048\*#** Jet Propulsion Lab., California Inst. of Tech., Pasadena.

**VEHICLE TEST REPORT: JET INDUSTRIES ELECTRA VAN 600**

T. W. PRICE and V. A. WIRTH, JR. 15 Feb. 1982 50 p refs (Contract NAS7-100; DE-AI01-78CS-54209)

(NASA-CR-168986; JPL-PUB-82-36; NAS 1.26:168986;

DOE/CS-54209/9) Avail: NTIS HC A03/MF A01 CSCL 13F

The Electra Van 600, an electric vehicle, was tested. Tests were performed to characterize parameters of the Electra Van 600 and to provide baseline data to be used for comparison of improved batteries and to which will be incorporated into the vehicle. The vehicle tests concentrated on the electrical drive subsystem, the batteries, controller, and motor; coastdowns to characterize the road load and range evaluation for cyclic and constant speed conditions; and qualitative performance was evaluated. It is found that the Electra Van 600 range performance is approximately equal to the majority of the vehicles tested previously.

E.A.K.

**N82-26809#** Eagle-Picher Industries, Inc., Joplin, Mo.  
**NICKELZINC BATTERIES FOR RPV APPLICATIONS Interim Technical Report, 15 Dec. 1979 - 15 Nov. 1980**

D. DAPPERT Wright-Patterson AFB, Ohio AFWAL Jun. 1981 70 p

(Contract F33615-78-C-2058)

(AD-A111087; AFWAL-TR-81-2039) Avail: NTIS HC A04/MF

A01 CSCL 10C

Interim results are presented for a program dealing with the placement of nickel-zinc batteries in specific military applications, namely the BQM-34A and the PQM-102 Remotely Piloted Vehicles. The nickel-zinc system was chosen for these applications because RPV's demand a high quality secondary battery that offers a compromise between long life (calendar and cycle) and low weight and volume. Program tasks include continued development of the nickel zinc system, calendar and cycle life testing of the two candidate batteries, qualification testing, and flight testing in operational RPV's. Test results of developmental cells and batteries include cycle life testing of various separator materials, high rate/low temperature discharges with various types of nickel electrodes, zinc electrode substrate, and charging methods. Calendar and cycle life testing is underway which will demonstrate the ability of the nickel-zinc system to be routinely cycled over an extended period of time.

Author (GRA)

## 07 ENERGY STORAGE

**N82-26851#** Nebraska Univ., Lincoln.  
**MEMBRANE-LINED FOUNDATIONS FOR LIQUID THERMAL STORAGE Final Report, 1 May 1978 - 31 Dec. 1979**  
R. C. BOURNE Jun. 1981 102 p refs  
(Contract DE-AS02-78ET-20111)  
(DE82-003651; DOE/ET-20111/1) Avail: NTIS HC A06/MF A01

The membrane lined storage (MLS) container which is a spinoff of vinyl-lined swimming pool and waterbed technologies was developed. The state of development of MLS was evaluated and concepts for MLS structural and heat transfer systems were improved. Preferred structural supports were identified and designed for 1500 gal MLS containers for basement, crawl space, and slab-on-grade foundation types. Techniques are developed to provide space heating via forced air through a finned storage jacket for the two preferred structural enclosure designs. Cost effectiveness of the direct air heating technique is evaluated. Alternate free convection domestic water preheaters and a preferred heat exchanger material is selected. Collector and space heat inlet/outlet designs, design concepts for auxiliary heat input to MLS from resistance electric, combustion, and heat pump sources are developed. DOE

**N82-26852#** Hittman Associates, Inc., Columbia, Md.  
**BATTERY RESOURCE ASSESSMENT. VOLUME 1: SCENARIOS, INVESTMENT, AND MATERIALS COST**  
D. SULLIVAN Jun. 1981 123 p refs  
(Contract DE-AC02-80CH-10026)  
(DE82-006243; DOE/CH-10026/2A) Avail: NTIS HC A06/MF A01

The possibility of widespread use of storage batteries for load leveling, photovoltaic, and electric vehicle applications creates a potential for major shifts in the utilization of various resources. In addition to materials requirements, significant investments will be required in order for the battery industry to manufacture a large number of batteries. A study to identify the resources required for a significant expansion of the battery industry and especially to note resources that may be strained as a result of accelerated battery development is presented. Scenarios of future battery demand, an analysis of battery manufacturing investments, an analysis of battery price sensitivity to materials prices, and an analysis of the availability of several key battery materials are included. DOE

**N82-27691#** Army Cold Regions Research and Engineering Lab., Hanover, N. H.  
**TRANSIENT ANALYSIS OF HEAT TRANSMISSION SYSTEMS**  
G. E. PHETTEPLACE Dec. 1981 63 p refs  
(Contract DA PROJ. 4A7-62730-AT-42)  
(AD-A112365; CRREL-81-24) Avail: NTIS HC A04/MF A01  
CSCL 20M

This report develops a method of analysis for heat transmission systems operating under district heating load conditions. The method accounts for the effects of heat source and load characteristics. The use of thermal energy storage systems is outlined and advantages are given. The transmission model itself considers the following technical aspects: (1) frictional pressure losses in piping system, (2) pump characteristics, (3) pump driver characteristics, and (4) heat losses from the buried piping. The capital costs considered are the piping system and necessary pumps. Operation and maintenance costs include cost of heat loss and cost of pumping energy input. Allowances are also made for system maintenance and repair over the assumed lifetime. GRA

**N82-27749#** California Univ., Livermore. Lawrence Livermore Lab.

**DESIGN AND FABRICATION OF CONTAINMENT RINGS FOR USE IN TESTS OF SIX PROTOTYPE FLYWHEEL ROTORS**  
A. P. COPPA (General Electric Co., Philadelphia) Feb. 1981 106 p refs  
(Contract W-7405-ENG-48)  
(DE81-030357; UCRL-15370) Avail: NTIS HC A06/MF A01

Containment rings were designed and fabricated to perform prototype flywheel rotor tests. Six open containment ring designs were developed based on the characteristics of six different rotors each with a particular failure mode. The containment requirements for each rotor and the designs developed are described. DOE

**N82-27750#** Societe Nationale Industrielle Aerospatiale, Les Mureaux (France). Div. Systems Balistiques et Spatiaux.  
**MAGNETIC BEARING FLYWHEELS FOR ELECTRIC STORAGE**  
P. C. POUBEAU 1981 11 p refs Presented at Intern. Energy Agency Conf. on New Energy Conservation and their Commercialization, Berlin, 6-10 Apr. 1981  
(SNIAS-821-422-110) Avail: NTIS HC A02/MF A01

A magnetic bearing flywheel was designed. In order to have a simple, reliable system, magnetic suspension with a single servoloop for one degree of freedom of the rotor was used, four other degrees of freedom being controlled passively and the sixth one, corresponding to the rotation axis. The motor that transfers electric energy to the rotor is of the ironless brushless dc type with electronic commutation. It is operated alternatively for accelerating the wheel and then as a generator for delivering the stored energy. The use of high stress composite materials in the rotor greatly increases the operational limits of this equipment. Key characteristics of kinetic energy storage are mentioned along with a wide range of applications. Besides energy storage for satellites, these include power smoothing for solar and wind energy systems as well as backup power supplies, e.g., for electric vehicles. Author (ESA)

**N82-27751#** Societe Nationale Industrielle Aerospatiale, Les Mureaux (France).  
**MAGNETIC SUSPENSION AND FLYWHEELS: SPACEBORNE AND TERRESTRIAL APPLICATIONS [LA SUSPENSION MAGNETIQUE ET LES VOLANTS D'INERTIE: APPLICATIONS SPATIAUX ET TERRESTRES]**  
P. C. POUBEAU 1981 4 p In FRENCH Presented at Conf. Aerospatiale a la Journee sur l'Espace et son Futur, Toulouse, Oct. 1981 Sponsored by SITEF  
(SNIAS-821-422-111) Avail: NTIS HC A02/MF A01

Satellite attitude control, using inertia wheels, is discussed. Elimination of friction effects through application of magnetic bearings is considered. The inertia wheel/magnetic bearing configuration can also be used to store kinetic energy. Higher rotational velocities create a need for stronger rotor construction materials; improved mechanical properties can be achieved with composite materials. Kinetic energy storage for earthside applications (solar energy storage; electric vehicles) is mentioned. Author (ESA)

## 08

### GENERAL

**A82-28642**  
**THE PRACTICAL UTILISATION OF FIBRE COMPOSITE HYBRIDS**

W. PATON (National Engineering Laboratory, East Kilbride, Scotland) In: Fibre composite hybrid materials. London, Applied Science Publishers, 1981, p. 221-260. refs

The application potential and practical approaches to the design of hybrid components and structures are discussed and illustrated by examples of applications in automotive, aerospace, and energy

generation fields. Advantages in design and manufacture due to hybridization include increased structural stiffness, the possibility to control the coefficient of thermal expansion to match design requirements, high dimensional stability, corrosion resistance, and the possibility of accurate control of in-plane and through-thickness conductivity. Cost-effective hybridization depends on accurately matching laminate and reinforcement configurations within a product to an adequate performance specification; maximum structural utilization of the more expensive high performance phase is particularly important.

V.L.

**A82-29483****FRACTURE MECHANICS OF DUCTILE AND TOUGH MATERIALS AND ITS APPLICATIONS TO ENERGY RELATED STRUCTURES**

H. W. LIU, (ED.) (Syracuse University, Syracuse, NY), T. KUNIO (Keio University, Yokohama, Japan), V. WEISS (Syracuse University, Syracuse, NY), and H. OKAMURA (Tokyo, University, Tokyo, Japan) The Hague, Martinus Nijhoff Publishers, 1981. 330 p \$53

The evaluation, prediction, and calculation of failure processes in ductile energy related structures are examined. The J-integral is considered, including applications in estimations of structural strength, for cracks in nuclear reactor vessels, for fracture analyses of tough materials, for the development of plastic fracture mechanics capabilities, and for relationships between the J-integral and crack tip opening displacement. Experiments are reported with the J-integral being used for evaluating the crack tip plastic blunting and the elastic-plastic fracture, a semi-elliptical surface crack, and elastic-plastic toughness of irradiated steels. Stress, strain, and COD are discussed as fracture criteria, and the effects of material properties on fracture toughness are investigated. Finally, the fracture mechanics of creep and fatigue are explored, along with fatigue limits, notch sensitivity, and low cycle fatigue in metals.

M.S.K.

**A82-33029****FRACTURE STRENGTH OF SINTERED AND SILICONIZED SiC AND SiC JOINTS**

G. G. TRANTINA (GE Research and Development Center, Schenectady, NY) American Ceramic Society Bulletin, vol. 61, May 1982, p. 555-558. Research supported by the Electric Power Research Institute. refs  
(ACS PAPER 35-N-80)

Fracture strength properties that are related to the design of ceramic structures were evaluated. Sintered alpha SiC with a coarse microstructure exhibits more strength degradation at 1500 C than does alpha SiC with normal microstructure. The strength of a siliconized SiC can be increased by about 25% with a one hour/1200 C treatment and can be further strengthened (15-30%) by exposures to 1200 C and stress. Similarly, the strength of siliconized SiC joints can be increased by a one hour/1200 C exposure and further strengthened by exposures to 1200 C and stress. Both sintered alpha and siliconized SiC exhibit a size effect in the fracture strength that can be treated with a Weibull statistical approach.

(Author)

**N82-23137#** Messerschmitt-Boelkow-Blohm G.m.b.H., Ottobrunn (West Germany). Zentralbereich Entwicklung.

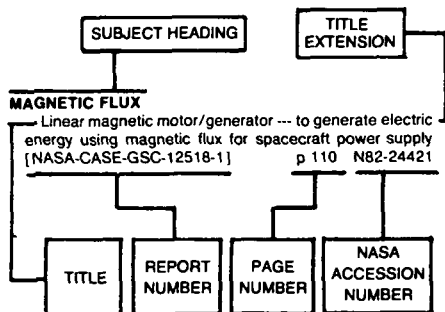
**RESEARCH AND DEVELOPMENT AT MBB. TECHNICAL AND SCIENTIFIC PUBLICATIONS, 1981 [FORSCHUNG UND ENTWICKLUNG. TECHNISCH-WISSENSCHAFTLICHE VEROEFFENTLICHUNGEN 1981]**

1981 193 p refs Partly in ENGLISH and GERMAN

Avail: NTIS HC A09/MF A01

Research and development work carried out during 1981 at Messerschmitt-Boelkow-Blohm GmbH, Ottobrunn, FRG is presented. Aerodynamics, materials science, infrared imagery, aircraft and spacecraft design, and production engineering are discussed. Calculation methods, mathematical and scale models, and computer aided design are treated. Solar energy and high speed trains were investigated.

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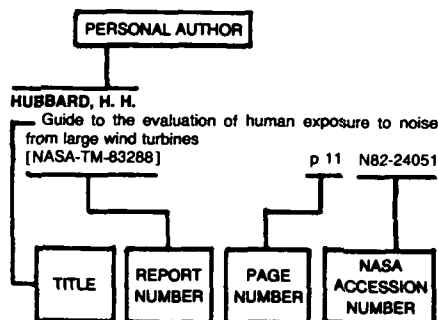
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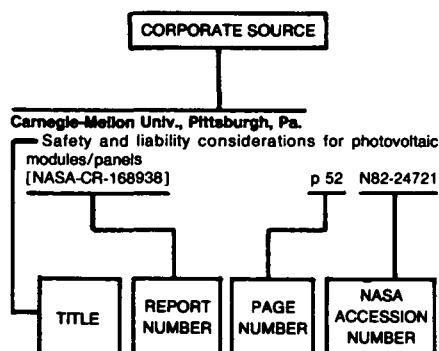
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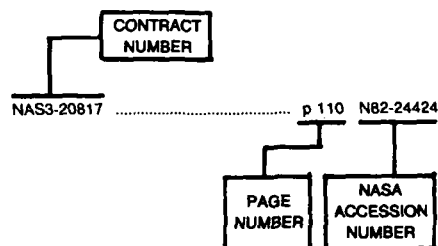
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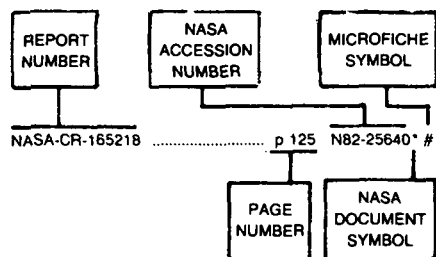
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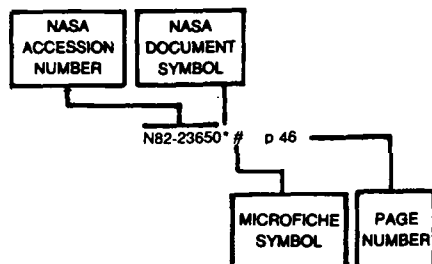
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